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Failure Study and Proposed Solution for Hinged Belt Conveyor System used for Wheel Lathe Machines

Rajat R Gadhave[1]
[1]*Mechanical Engineering Department, Pillai College Of Engineering, Mumbai University.*

Abstract*: This paper presents the study of problems associated with the Hinged Belt Chip Conveyor System used for Wheel Lathe Machines. These problems lead to the failure of the system and cause various losses in terms of time, money, etc. The objective of this paper is to identify the problems and study these problems and their causes and provide solutions to overcome these problems and increases the efficiency of the system. As the Chip conveyor system is an indispensable tool of modern equipment; it can be widely used in CNC machine tools, combined machine tools, machining center, specialized machine tools, assembly line and automatic chip conveyor line. Thus it needs to have high transmission efficiency and efficient conveying speed.
Keyword: Hinged Belt conveyor, Chip Conveyor system, Wheel Lathe Machine, Chips.

I. INTRODUCTION

Chip conveyor is an indispensable tool of modern equipment; it can be widely used in CNC machine tools, combined machine tools, machining center, specialized machine tools, assembly line and automatic chip conveyor line. It has high transmission efficiency and efficient conveying speed. Chip conveyor system is used where there is heavy duty operation performed and there is high metal removal rate.

Chip conveyor is a material handling system used to automate chip removal and increase the productivity of the machine. Chip conveyor is a used primarily in industries to carry away waste, such as a metal chip. Wheel lathe performs e operations like turning, facing and boring which produce metal chips. As these machines are heavy duty machines large quantity of heavy chips are produced. As all these machines are CNC SPM machines so the chip removal process should also be automatic to increase efficiency. Also, removal of these chips manually is very difficult. Thus chip conveyors are used for such machines.

The source of chips is the machining process where there is gradual removal of excess material from the preformed blanks in the form of chips [1]. The form of machined chips depends mainly upon work material, material and geometry of the cutting tool, levels of cutting velocity and feed and also to some extent on a depth of cut, machining environment or cutting fluid that affects temperature and friction at the chip-tool and work-tool interfaces [2].

A. Types of Chips & Conditions for Formation of Those Chips

1) *Different types of chips of various shape, size, colour etc. are produced by machining depending upon [3] :*
   - *a)* Type of cut, i.e., continuous (turning, boring etc.) or intermittent cut (milling)
   - *b)* Work material (brittle or ductile etc.)
   - *c)* Cutting tool geometry (rake, cutting angles etc.)
   - *d)* Levels of the cutting velocity and feed (low, medium or high)
   - *e)* Cutting fluid (type of fluid and method of application)

2) *The basic Major Types of Chips And the Conditions Generally Under Which Such Types of Chips form are Given Below*
   - *a) Discontinuous* type

     Desirable for ease of chip disposal, fluctuating cutting forces, can affect surface finish and cause vibration and chatter. Of irregular size and shape: work material – brittle like grey cast iron. Of regular size and shape: work material ductile but hard and work hardenable

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b) Continuous type

Good surface finish; steady cutting forces; undesirable in automated machinery. Work material – ductile, Cutting velocity – high, Feed – low, Rake angle – positive and large, Cutting fluid – both cooling and lubricating.

II. HINGED BELT CONVEYOR

Hinge –Belt chip conveyor as shown in Fig. 1, is the most common format, which offers effective means of managing heavy chip loads and stringy chips. Chips that fall from the machine tool land on the conveyor belt and are conveyed away from the machine tool's precision surfaces. These are heavy duty conveyors that can handle a large quantity of long, curly, bushy chips and find application in machines that generate heavy chips/ swarf as in wheel turning lathes. These conveyors are also used as collecting conveyors over larger distances.Hinge-Belt chip conveyors are best for wheel lathe machines as they convey large quantity of long, curly and bushy chips.

Fig. 1 Hinged- Belt Conveyor

A. Hinge- belt chip conveyor consists of:

1) Hinged metal plate

Hinged metal plate as shown in Fig. 2 is a steel plate with integral piano hinges through which axles pass. There are many aprons on hinge belt at specific distance.

Fig. 2 Hinged Metal Plate

2) Apron

Apron as shown in Fig. 3is a metal plate welded to hinge steel plate at specific distance. Apron plates are used to handle chip.

Fig. 3 Apron

3) Rollers 4. Cotter pins 5. Side plates/side link

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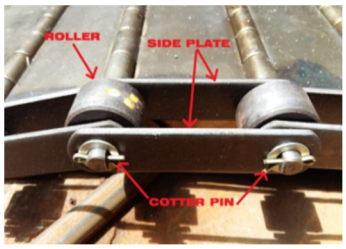

Fig. 4Rollers, Cotter Pins & Side Plates/Side Link

4) Side wings

Side wings as shown in Fig. 5 are held by axel passing through them. Overlapping construction forms flush jam proof inner surface. No welds are done to replace when damaged.

Fig. 5 Side Wings

5) Geared motor

Motor with gear boxis provided to produce power or torque required by the conveyor system.

6) Chain & Sprockets

Chain and sprocket arrangement is provided to transfer power from the geared motor shaft to the chip conveyor shaft.

7) Torque Limiter

Torque limiter is a protective device that limits torque transmitted in a drive system by slipping when torque demand exceeds a preset value as a result of shock load, overload or machine jams. It automatically re-engages when the overload torque has passed. It utilizes spring loaded friction surface for its operation; slip torque is preset by adjustment of the spring force [4].

III. PROBLEMS AND CAUSES

A. Problem and causes are as shown below:

1) Problem: Stopped Conveyor.
Cause: Jammed with chip due to:
Chip gets stuck on the bearing shaft area as shown in Fig. 6.

Fig. 6 Chip Stuck on the Bearing Shaft

Chip gets stuck between the side links and roller as shown in Fig. 7.

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Fig. 7 Chip Stuck Between the Side Links & Roller

Length of chip too long as shown in Fig. 8.

Fig. 8 Chips of Profiling Operation on Wheel Lathe Machine

2) *Problem:* Excessive jamming without any evidence of anything is blocking the conveyor.
Cause : Too little tension in belt.

3) *Problem:* Axel bent or broke.Bearing not working properly or damaged.
Cause : Corrosion of axel and become weak and bearing corrode as the pit is filled with water

4) *Problem:* Bent or torn side wings as shown in Fig. 9.
Cause : Too heavy load or supply of large chips and jamming due to chips.

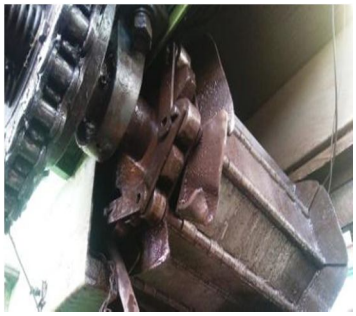

Fig. 9 Bent Side Wings

Overlapping surface of side wings doesn't form jam proof inner surface as shown in Fig.10.

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Fig. 10 Side Wing Gap

5) *Problem:* Bent or torn hinge loops as shown in Fig. 11 of hinge plates
Cause *:* Worn away by rust or worn away as a result of insufficient lubrication and become weak.

Fig. 11 Torn Hinge Loops

6) *Problem:* Motor rotating but conveyor shaft not rotating
Cause : Key of the coupling is sheared.Bearing is damaged as shown in Fig. 12.

Fig. 12 Damaged Bearing

7) *Problem*: Gear box not working
Cause *:* Gears are worn out.

8) *Problem:* Motor working but gear box not working but gearbox is ok
Cause *:* Motor shaft key worn out or sheared.

9) *Problem:* Hinge steel plate bent or shear as shown in Fig. 13
Cause *:* Too heavy load or supply of large chip and jamming due to chips.

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Fig. 13Sheared Hinge Plate &Bent Hinge Plate

IV. PROPOSED SOLUTION

A. Chip conveyor jamming is the main problem which leads to many problems. Chips get stuck on the bearing shaft, between the side links and roller at the interface between the two conveyors, between the side wings and also due to roll back of chip during the return of conveyor belt.

1) The problem with chip is its length. The length of chip very long. These long chips get wound on the shafts and damage the bearings.Thus length of chip should be small so that the bearings will not be damaged and also the small length chips will have a distributed weight on the conveyor belt. A chip crusher could be used for that purpose.

2) Chips get stuck between side links and rollers where the chips are transferred from one conveyor to another. At that section only these parts are exposed to chips. If at this section those parts are covered by metal casing as shown in Fig. 14, chips will not stuck and lead to jamming of chip conveyor, damaged roller and gear and wear of side links.

Fig. 14 Casing for Rollers

3) At the section where the chips are transferred from one conveyor to another the chips sometimes return back with the belt in 1st conveyor only. These bird nest like chips jam the conveyor. Height difference between two conveyors should be maintained proper. Metal plate as shown in Fig. 15 with good strength could be provided at the bottom side so that there will be no room for the chips to return back.

Fig. 15 Metal Plate to Stop Return of Chips

4) Length of chip is very long and leads many problems. This length of chip could be reduced by using a proper crusher. Crusher should be such that it will reduce the length of chip to considerable amount. Chip length can also be reduced by using tool insert with proper chip breaker. If proper chip breaker used it would break the chips and the conveyor could handle small length chips.

B. Chain belt has to be adjusted for proper tension prior to start up.Retightening of belt has to be done after every working day.

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C. Conveyor system is in a pit underfloor. If this pit is filled with water due to rain or any reason and the water is not pumped out, then the bearings, shaft, rollers, plates etc. gets corroded and become weak. The shaft become weak and is bent or broke during operation. The bearings are damaged. Thus water accumulation in the pit of the conveyor system should not happen and care should be taken of that.

D. Heavy load of chips should not be applied on the conveyor. This heavy chips damage the side wings.

E. Overlapping construction of side wings should form jam proof inner surface.Radial side wings as shown in Fig. 16 can be used which form jam proof inner surface.

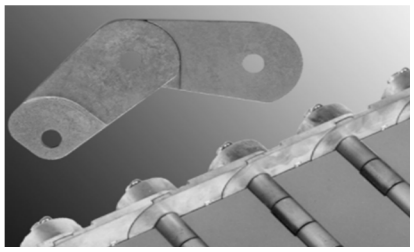

Fig. 16 Radial Side wings

F. Lubrication system should be checked. Hinges should be lubricated and damaged hinges should be replaced.

G. Sometimes motor shaft rotates but the conveyor shaft does not rotate. This problem is caused due to key of coupling is sheared or bearing is damaged. Thus the bearing needed to be inspected for damaged

H. Key of motor should be provided good strength because due to frequent forward and reverse of conveyor, wear of key takes place

I. The conveyor system should be started before machine starts and shall stop after the machine stops.

J. Proper maintenance schedule as prescribed by the manufacturer should be followed.

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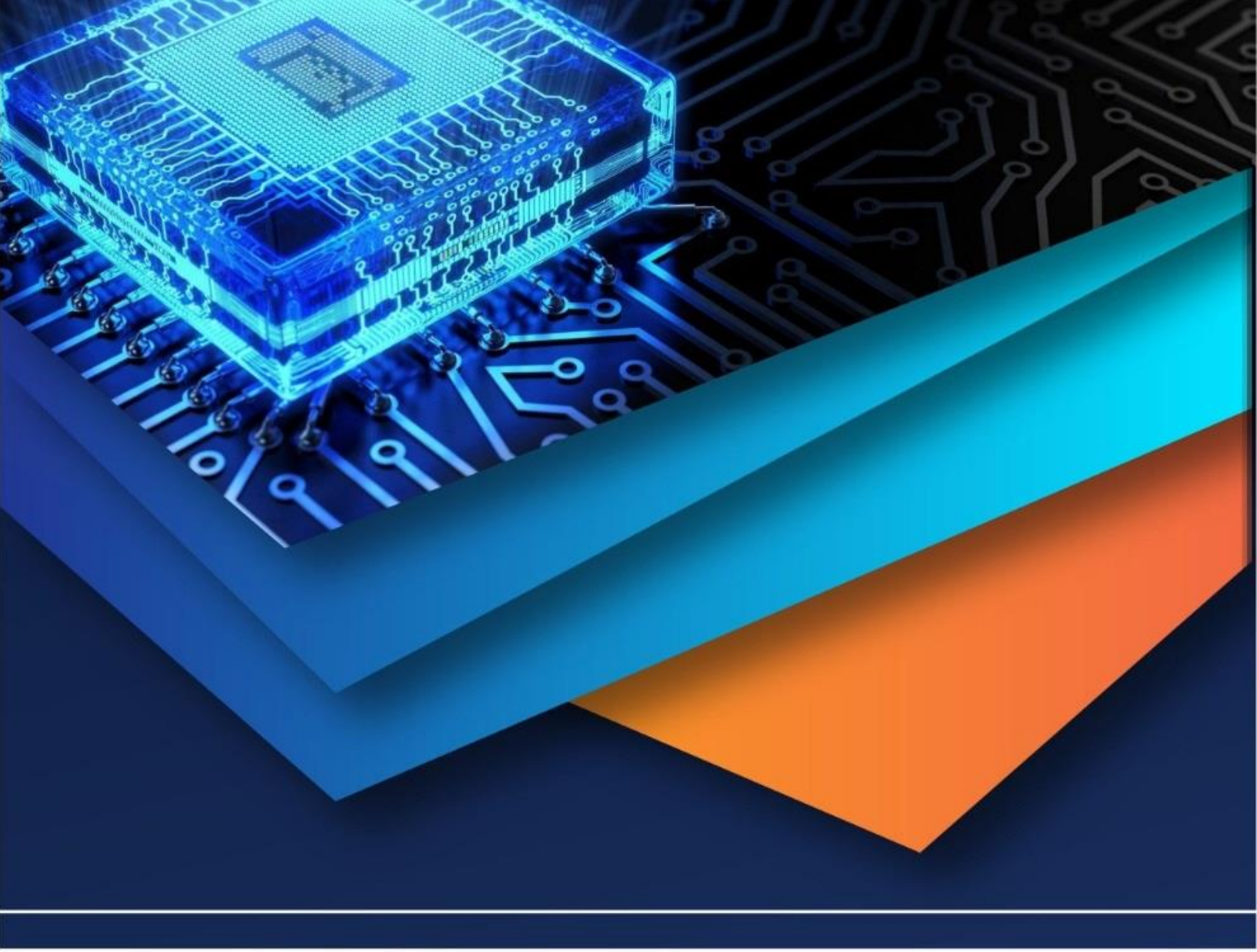

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