RENOLD

Troubleshooter

PRODUCT RANGE

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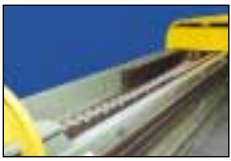
INTRODUCTION

Renold, the premier chain company is dedicated to providing national and global customers with products to the ultimate specification and design, manufactured to exceed the highest international standards.

Only materials that meet the Renold exacting specifications are used for the manufacture of our chain components.

Stringent process control at every stage of production including component manufacture, heat treatment, and assembly, ensure the consistent quality of all Renold Chain.



Every chain is proof loaded resulting in minimum initial wear, greater fatigue resistance and improved wear performance.

Corrosion protection and long life are achieved by automatically pre-lubricating every chain with a specially formulated grease. Chain lubrication is one of the most important factors in achieving a long and trouble free service life. Renold can advise the correct method to suit your needs.

A feature of power transmission and mechanical handling is that, if a machine is overloaded or otherwise used in a manner not allowed for in the design, then the effects will always be seen in the performance or appearance of the chain or sprockets.

The purpose of this booklet is to highlight some of the types of damage that can be caused to chain or sprockets by specific design oversights, maintenance neglect and operational overloads, enabling retification and improved performance.

CONVEYOR INTRODUCTION

Renold Chain has, for many years, been a leader and innovator involved in the design and manufacture of standard conveyor chain and the development of engineered products for such applications as escalators, travelators, sterilisers, cement conveyors, theme park rides and numerous other specialised systems for the mechanical handling industry. We have a detailed understanding of the maintenance needs on such applications and can now offer the manufacturers and operators of conveyor systems the benefits of this knowledge.

Chain is one of the most widely used moving mediums in mechanical handling systems, being robust and very adaptable, but it is also one of the most neglected components within such equipment when general or routine maintenance is carried out. In many cases this product is attended to when problems occur, normally when the chain is already damaged and the only real option is to fit a replacement to the system.

For more information on Conveyor Chain, please refer to the **Renold Chain Installation and Maintenance Manual** which has been designed with the manufacturer and operator in mind. It covers the functional aspects of using Renold conveyor chain and emphasises the correct use of preventative maintenance procedures, which will ensure better machine performance, less down time, lower overall maintenance costs and extended chain life. Should you require any further information, please contact our technical sales staff.

Figure 1

FIGURE 1	MODE OF FAILURE - ABRASION

APPLICATION	134,000 *N* breaking load chain operating on a slat conveyor with slats bolted across the K attachments.
FAILURE MODE	Side plates showed severe rubbing marks along one edge.
DIAGNOSIS	The side plate edges have been rubbing against some fixed point on the conveyor structure, probably the edge of the guide tracks. The effect of this would be to wear away the side plate and to increase the drive power and chain tension.
SOLUTION	Determine the point of contact and realign the chain to prevent rubbing. It may be necessary to check and adjust the track to ensure levels are correct across the two strands.

Figure 2

FIGURE 2	MODE OF FAILURE - ABRASION

APPLICATION	Conveyor chain used in handling wet china clay.
FAILURE MODE	Severe wear between the chain bush and roller in a china clay extraction plant.
DIAGNOSIS	Abrasive residues (Quartz) in the clay from the original granite material causing wear to the surfaces.
SOLUTION	Specify Renold Chain with extra hard surface materials to be included in the manufacture of chain round parts.

Figure 3

FIGURE 3	MODE OF FAILURE - ALIGNMENT

APPLICATION	Can steriliser chain.
FAILURE MODE	Wear to the pin ends has removed the rivet security and the outer plate has become detached.
DIAGNOSIS	Differential wear to the chains has caused the vertical strands to move to the side and contact the guides. The guides are of similar hardness to the pin ends and the pin ends have worn away releasing the outer side plate.
SOLUTION	Fit side guides that are softer than the pin ends. Also consider fitting a rubbing block at intervals along the chain to protect the pin end.

Figure 4

FIGURE 4	MODE OF FAILURE - ALIGNMENT

APPLICATION	Cast iron sprockets fitted to chain scraper conveyors used for cleaning the primary screens at a sewage treatment plant.
FAILURE MODE	Sprocket teeth suffered severe wear over a six month period and several teeth were so weakened that they fractured across the thinnest section.
DIAGNOSIS	The teeth were machined to a thinner section to accommodate flanged rollers on the chain and the chain was allowed to run out of line which resulted in only part contact on the sprockets. The resulting high pressure caused the rapid wear shown on the photograph.
SOLUTION	Replace the sprockets and realign the chain to ensure full contact between the chain roller and the sprocket teeth.

Figure 5

FIGURE 5	MODE OF FAILURE - CORROSION / EROSION

APPLICATION	Heavy duty chain used on a slat conveyor carrying cut sugar cane into a sugar factory.
FAILURE MODE	Severe corrosion and wear of pin and bush surfaces.
DIAGNOSIS	Chain pin and bush were supplied drilled for grease gun lubrication. No lubrication has been applied and the surfaces have been subjected to unprotected corrosion / erosion by acidic sugar juice and sand contamination.
SOLUTION	Replace the chain and ensure that the grease gun lubrication feature is regularly used.

Figure 6

FIGURE 6	MODE OF FAILURE - CORROSION / EROSION

APPLICATION	Threading chain for passing finished steel strip through the final washing and finishing process.
FAILURE MODE	Severe erosion of material from areas of the chain leading to weakening and tensile failure.
DIAGNOSIS	Sequence of environments between caustic, water and air at high pressure caused erosion / corrosion of the side plates which reduced the section side plates leading to tensile failure.
SOLUTION	Protection of the chain by either zinc plating or shielding to prevent the erosion.

Figure 7

FIGURE 7	MODE OF FAILURE - FRETTING

APPLICATION	Tilt tray sorter chain used in baggage handling in the baggage hall of a major airport.
FAILURE MODE	Chain pins and bi-planar block show scoring and heavy red deposit indicating fretting corrosion.
DIAGNOSIS	Fretting corrosion caused by marginal lubrication, where the lubricant present is insufficient to prevent the asperities on each component rubbing together.
SOLUTION	Every pin should be removed and all traces of abrasive red oxide removed. The chain should then be operated in an improved lubrication regime.

Figure 8

FIGURE 8	MODE OF FAILURE - IMPACT & ALIGNMENT

APPLICATION	Gravity bucket conveyor handling hot cement in a cement works.
FAILURE MODE	Heavy surface cracking on the surface of the bushes and abrasion of the inner faces of the side plates.
DIAGNOSIS	This problem appears to be caused by heavy impact on the bushes. The abrasion on the side plates suggests that the chain is riding up onto the top of the sprocket teeth and then dropping into engagement.
SOLUTION	Initially the alignment between the chain and the sprockets should be checked. If this is correct then the remaining alignments should be checked, i.e. sprocket centres, levels, chain centres, etc.

Figure 9

FIGURE 9	MODE OF FAILURE - MISALIGNMENT

APPLICATION	Conveyor chain roller profile after use on a twin strand slat conveyor.
FAILURE MODE	Eccentric wear across the face of the roller has caused a lip on one side.
DIAGNOSIS	The chain has run to one side to the degree where the roller edge has been over the edge of the chain track. The effect of this type of situation is to increase the roller face wear rate by only using part of the face width to carry the loads.
SOLUTION	Re-align the chain to run correctly on the chain tracks. In the failure shown the chain could be re-used with the lip ground off, providing the roller is a sintered through hardened type. Otherwise the chain should be replaced.

Figure 10

FIGURE 10	MODE OF FAILURE - MISALIGNMENT

APPLICATION	Heavy duty gravity bucket conveyor chain operating in a cement works.
FAILURE MODE	The extended bearing pin has failed across the hole which was drilled to allow lubricant into the outboard roller.
DIAGNOSIS	The chain has moved sideways until one of the rollers has fouled the conveyor structure causing the extended pin to fail. The cross section is interesting in that the fine grained hardened case and the coarse grained ductile core can clearly be seen.
SOLUTION	The circuit of the conveyor should be checked to find the contact point. The conveyor should be checked to find and correct the reason for the movement to the side.

Figure 11

FIGURE 11	MODE OF FAILURE - NONE

APPLICATION	107,000 *N* breaking load hollow pin.
FAILURE MODE	None.
DIAGNOSIS	A correctly lubricated component.
SOLUTION	

Figure 12

FIGURE 12	MODE OF FAILURE - OVERHEATING

APPLICATION	Stainless steel chain renewed in an oven operating at a high temperature.
FAILURE MODE	The replacement chain wore severely after a short time resulting in the removal for examination.
DIAGNOSIS	At the same time as replacing the chain, heat trap doors had been fitted which saved heat loss but increased the oven temperature to a level above the acceptable working value for the chain.
SOLUTION	Return to the previous method of working or accept a much reduced chain life. Heat resisting steels are a possibility.

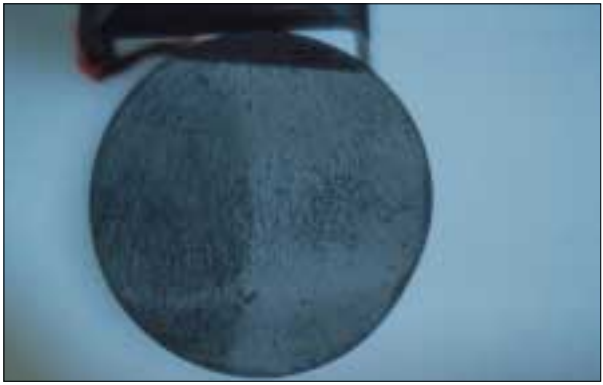


Figure 13

FIGURE 13	MODE OF FAILURE - OVERLOAD

APPLICATION	Extended pin fitted to chain to carry an outboard roller.
FAILURE MODE	Sudden shock overload has caused the pin to fail.
DIAGNOSIS	The extended pin has failed due to overload or shock loading. The failure has initiated at the corner of the flat on the pin. The "river markings" flowing away from the crack initial point can be clearly seen.
SOLUTION	Determine the reason for the shock / overload and either remove the cause or redesign the pin to carry the load.

Figure 14

FIGURE 14	MODE OF FAILURE - ROLLER SEIZURE

APPLICATION	Chain used in an oven conveying system.
FAILURE MODE	Rollers seized on bushes producing flats on roller outside diameters.
DIAGNOSIS	The grease lubrication used on the chain was not suitable for the oven temperature and during operation the grease 'carbonised' causing seizure of the rollers.
SOLUTION	Apply a light flushing oil to the chain to clean out the residue of carbon. If this is not successful then the chain must be replaced and lubricated with an oil compatible with the oven operating temperature.

Figure 15

FIGURE 15	MODE OF FAILURE - SPROCKET TOOTH WEAR

APPLICATION	Sprockets fitted at the end of a conveyor.
FAILURE MODE	Severe hooking wear of the sprocket teeth has been compounded with a second phase of hooked wear.
DIAGNOSIS	The original chain and sprockets have followed normal wear patterns with hooked wear of the sprocket teeth and pitch elongation of the chain. A new chain has then been fitted to the old wheels which have a worn tooth form incompatible with the pitch of the new chain. The result is severe secondary wear of the sprocket teeth and probably very rapid chain pitch extension.
SOLUTION	Always check the condition of the existing sprocket teeth before fitting a new chain to any system. In this case the sprockets must be renewed and the chain checked for damage.

Figure 16

FIGURE 16	MODE OF FAILURE - TENSILE OVERLOAD

APPLICATION	Bottle washer chain used for washing returned milk bottles in a caustic environment.
FAILURE MODE	The chain cranked link has failed in tensile mode.
DIAGNOSIS	The outer link has been crudely modified which was thinner than the normal inner link.
SOLUTION	Obtain a properly designed cranked link from Renold.

Figure 17

FIGURE 17	MODE OF FAILURE - GALLING

APPLICATION	Hollow pin (step pin) used in a high rise escalator.
FAILURE MODE	The pin pressure faces have suffered from severe galling where the surfaces have articulated and fused together.
DIAGNOSIS	The very high pressures experienced by these high rise escalators have led to squeeze-out and failure of the lubricant allowing the surfaces to touch and gall when the chain articulated.
SOLUTION	Use high quality, high pressure lubricants and ensure that the lubricant regime is such that the film of lubricant is constantly maintained between the surfaces.

LIFTING INTRODUCTION

Renold Chain has over 100 years experience in the operation and maintenance of lifting chain. Involvement with designers, manufacturers and users of all types of equipment has enabled Renold to develop the **Renold Lifting Chain Installation and Maintenance Manual** which should be referred to for more information. This definitive manual is designed to pass on the preferred methods of correct handling, adjustment, installation and maintenance of lifting chain systems resulting in maximum chain life.

If further information is required, please contact our technical sales staff.

Figure 18A

FIGURE 18A	MODE OF FAILURE - ALIGNMENT

APPLICATION	1" P 5 x 6 leaf chain used in a counterbalance mechanism for the drivers cab in an overhead crane.
FAILURE MODE	Excessive judder noticed by the crane driver.
DIAGNOSIS	Inspection of the counterbalance arrangement showed that the pulley had worn excessively on one side. This was reflected on one side of the chain. The pulley was found to be out of line with the line of action of the chain attachment points.
SOLUTION	Renew chain and pulley and realign.

Figure 18B

FIGURE 18B	MODE OF FAILURE - ALIGNMENT

APPLICATION	1" P 5 x 6 leaf chain used in a counterbalance mechanism for the drivers cab in an overhead crane.
FAILURE MODE	Excessive judder noticed by the crane driver.
DIAGNOSIS	Inspection of the counterbalance arrangement showed that the pulley had worn excessively on one side. This was reflected on one side of the chain. The pulley was found to be out of line with the line of action of the chain attachment points.
SOLUTION	Renew chain and pulley and realign.

Figure 19

FIGURE 19	MODE OF FAILURE - GALLING & FRETTING CORROSION
APPLICATION	Chain used for a lifting application.
FAILURE MODE	Galling and fretting corrosion.
DIAGNOSIS	The chain being under constant loading at high bearing pressure has resulted in the lubricant being squeezed out between the pin and bush bore. This created a metal to metal contact resulting in a slight galling of the surfaces and the oxidization of the microscopic particles, giving the red oxide deposit. A typical example of fretting corrosion.
SOLUTION	More frequent lubrication schedule to be introduced.

TRANSMISSION INTRODUCTION

Renold Chain have over 100 years experience in the operation and maintenance of transmission chain. Involvement with designers, manufacturers and users of all types of equipment has enabled Renold to develop the **Installation and Maintenance Manual** for Transmission Chain which should be referred to for more information. This definitive manual is designed to pass on the preferred methods of correct handling, adjustment, installation and maintenance of transmission chain drives resulting in maximum chain life.

Should you require any further information, please contact our technical sales staff.

Figure 20

FIGURE 20	MODE OF FAILURE - ABRASION

APPLICATION	Simple transmission chain drive.
FAILURE MODE	Rubbing wear on the face of the side plates, the end of the side plates and the pin end.
DIAGNOSIS	The chain has been rubbing against some fixed point on the circuit. From the wear pattern it seems likely that the chain has worn a groove in the fixture, probably initiated by the harder pin ends.
SOLUTION	Realign the chain drive before the damage to the chain becomes too serious and the chain has to be scrapped.

Figure 21

FIGURE 21	MODE OF FAILURE - ABRASION

APPLICATION	Stainless steel transmission chain used to remove produce from the cooking oil in an automatic fryer.
FAILURE MODE	The chain suffered rapid pin/bush wear and pitch extension.
DIAGNOSIS	When the oil at the delivery end of the fryer was examined, it was found to contain product residue that had been degraded to form very hard burnt particles, that were abrading the chain round parts.
SOLUTION	Fit replacement chain and introduce a filtration system to the cooking oil to remove the abrasive residue.

Figure 22A - Before Cleaning

FIGURE 22A	MODE OF FAILURE - CORROSION
APPLICATION	1 3/4" ANSI simple detachable chain used on a table roll drive in a steel mill.
FAILURE MODE	Heavy corrosion and erosion of all parts.
DIAGNOSIS	Bush and rollers have corroded / worn to a wafer thin condition with corresponding wear on the pins. Plates have a great deal of side wear and are heavily pitted. This chain has been used in an extremely hostile environment subject to high temperatures and water spray.
SOLUTION	Improve lubrication methods. Replace chain more frequently.

Figure 22B - After Cleaning

FIGURE 22B	MODE OF FAILURE - CORROSION
APPLICATION	1 3/4" ANSI simple detachable chain used on a table roll drive in a steel mill.
FAILURE MODE	Heavy corrosion and erosion of all parts.
DIAGNOSIS	Bush and rollers have corroded / worn to a wafer thin condition with corresponding wear on the pins. Plates have a great deal of side wear and are heavily pitted. This chain has been used in an extremely hostile environment subject to high temperatures and water spray.
SOLUTION	Improve lubrication methods. Replace chain more frequently.

Figure 23

FIGURE 23	MODE OF FAILURE - CORROSION
APPLICATION	Chain drive used on a barrelling machine.
FAILURE MODE	Corrosion.
DIAGNOSIS	This chain has been used in an environment with water contamination. The chain has not been regularly lubricated and external parts have gradually corroded until the rollers seized. The chain has then proceeded to wear heavily on the rollers.
SOLUTION	Protect from water if possible. Increase degree of maintenance lubrication.

Figure 24

FIGURE 24	MODE OF FAILURE - FRACTURE

APPLICATION	1.25" P BS zinc plated chain used in a water environment.
FAILURE MODE	Bushes fractured on assembly
DIAGNOSIS	Customer supplied zinc plated bushes for assembly. When assembled the bushes broke into several fragments due to hydrogen embrittlement as they had not been de-embrittled after plating.
SOLUTION	Ensure correct de-embrittlement treatment is carried out immediately after plating.

Figure 25

FIGURE 25	MODE OF FAILURE - FRACTURE

APPLICATION	1.0" P BS chain.
FAILURE MODE	Plates fractured when chain working load was applied.
DIAGNOSIS	Chain had been zinc plated by customer without carrying out any de-embrittlement treatment which resulted in chain failure due to hydrogen embrittlement.
SOLUTION	Chain should be initially zinc plated before assembly by Renold.

Figure 26

FIGURE 26	MODE OF FAILURE - FRETTING CORROSION

APPLICATION	Transmission chain with pushers at intervals to control the conveying of boxes of breakfast cereal.
FAILURE MODE	Severe wear of one pin of the pusher attachment and red deposit indicating fretting corrosion.
DIAGNOSIS	The pusher attachment was designed 50.8mm pitch to fit on a chain of 25.4mm pitch and operate on sprockets designed for 25.4mm pitch chains. This obviously caused very high pressure on one pin of the attachment link which squeezed out most of the lubricant. This resulted in the marginal lubrication situation required to produce fretting corrosion.
SOLUTION	1. Use specially designed sprocket teeth with relieved tooth pocket at the attachment position. 2. Employ a high performance lubricant with solid residue to prevent squeeze-out.

Figure 27

FIGURE 27	MODE OF FAILURE - GALLING

APPLICATION	2.5" P ANSI chain used on a lifting application.
FAILURE MODE	The bearing areas have suffered galling where the surfaces have articulated and then fused together.
DIAGNOSIS	Very high bearing pressures had been experienced in this lifting application. The effect being that the lubricant had failed and galling had occured on articulation.
SOLUTION	Use a high quality, high pressure lubricant and ensure that a film of lubricant is maintained between mating surfaces.

Figure 28

FIGURE 28	MODE OF FAILURE - GALLING

APPLICATION	3.5" P BS chain used on a marine diesel engine.
FAILURE MODE	Severe galling due to high bearing pressures and lack of lubrication between articulating surfaces resulting in surfaces fusing together.
DIAGNOSIS	Lubrication pump failure resulted in surfaces fusing together under high bearing pressure. This galling process is also referred to as 'micro welding'.
SOLUTION	Ensure adequate means of lubrication.

Figure 29A

FIGURE 29A	MODE OF FAILURE - LUBRICATION & ALIGNMENT

APPLICATION	1" P BS duplex chain driving a flywheel on a 400 Tonne press.
FAILURE MODE	Excessive wear. Chain jumping teeth causing tooth rounding.
DIAGNOSIS	Examination of the chain showed no lubrication had been applied in the 6 months service life. The loads involved require a minimum of oil sump lubrication. In addition to this the centre distance was higher than recommended and the sprockets were out of line.
SOLUTION	Improve the lubrication method. Consider hardening the driver teeth. Correct the drive alignment.

Figure 29B

FIGURE 29B	MODE OF FAILURE - LUBRICATION & ALIGNMENT

APPLICATION	1" P BS duplex chain driving a flywheel on a 400 Tonne press.
FAILURE MODE	Excessive wear. Chain jumping teeth causing tooth rounding.
DIAGNOSIS	Examination of the chain showed no lubrication had been applied in the 6 months service life. The loads involved require a minimum of oil sump lubrication. In addition to this the centre distance was higher than recommended and the sprockets were out of line.
SOLUTION	Improve the lubrication method. Consider hardening the driver teeth. Correct the drive alignment.

Figure 30

FIGURE 30	MODE OF FAILURE - LUBRICATION & INSTALLATION

APPLICATION	Special 2 1/2" P ANSI simple chain used for conveying in a mine.
FAILURE MODE	No 58 pin suffered a fatigue failure.
DIAGNOSIS	The joint was extremely dry and showed no signs of lubrication. The joint showed heavy galling with the presence of surface corrosion products. Subsequent investigation revealed that the chain had been running in water, but more significantly that the user had opened out the holes on the loose plate of the No 58 joint to make assembly easier. This caused the fatigue failure experienced.
SOLUTION	Provide a better lead in on the pin to enable the user to assemble more easily. Reconsider lubrication regime.

Figure 31

FIGURE 31	MODE OF FAILURE - MATERIAL CRACKING BELOW TEETH

APPLICATION	0.5" P BS 20 tooth sprocket.
FAILURE MODE	Material cracking below teeth.
DIAGNOSIS	Customer had flame hardened the teeth incorrectly. Due to the differential rate of cooling resulting from the sprocket section, cracking occured.
SOLUTION	Sprockets to be supplied with teeth already flame hardened by Renold.

Figure 32

FIGURE 32	MODE OF FAILURE - OVERLOAD

APPLICATION	1.5" P BS chain test sample.
FAILURE MODE	Outer plates have been permanently stretched due to the high load.
DIAGNOSIS	Good example of overload.
SOLUTION	Correctly size the chain for the application.

Figure 33

FIGURE 33	MODE OF FAILURE - OVERLOAD

APPLICATION	Duplex transmission chain used in severe overload situation.
FAILURE MODE	Severe damage to transmission chain pin and collapse of the chain bush.
DIAGNOSIS	Excessive overload on the chain led to the collapse of the bush and damage to the pin.
SOLUTION	Correctly size the chain for the application.

Figure 34

FIGURE 34	MODE OF FAILURE - RIVETING FAILURE

APPLICATION	Simple transmission chain drive to a machine.
FAILURE MODE	One outer link has become detached and the pin bent.
DIAGNOSIS	The loose side plate of a No 107 connecting link has become detached due to inadequate riveting on site. The pin has moved out and jammed in position allowing the chain to continue working until the failure was noticed.
SOLUTION	Replace the No 107 link and ensure that the pins are adequately riveted.

Figure 35

FIGURE 35	MODE OF FAILURE - WEAR

APPLICATION	1.5" P BS duplex chain.
FAILURE MODE	Pin bearing areas worn. Note position of intermediate plates is clearly visable.
DIAGNOSIS	Over a long period of time the pins have gradually worn until the chain elongation has reached 2%
SOLUTION	Monitor chain extension regularly.

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INDEX

A LONG & TROUBLE FREE LIFE

To obtain the maximum performance from a set of chains and sprockets, maintenance needs to be planned and carried out on a regular basis. This will not only ensure optimum chain life, but will reduce downtime and limit inconvenience when chain replacement is necessary.

The cases in this guide are typical examples of failure modes. They can all be avoided with a little forethought.

Despite working in a wet environment for over 60 years, the end of life inspection revealed this Renold chain to still be in good condition.

This can mainly be attributed to the maintenance schedule undertaken by the customer.

To ensure your Renold chain achieves maximum life refer to the Renold Chain Products Installation and Maintenance Manual.

NOTES

NOTES

NOTES

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