Roller Chain Design Hints

A guide to Roller Chain drives

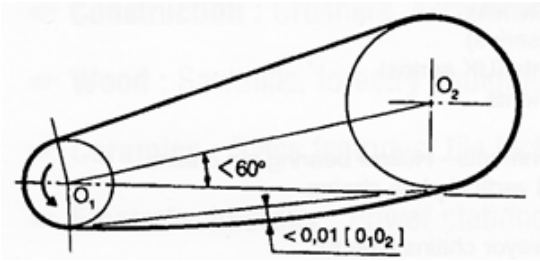
Design Hints

The reliability of a chain, whatever its application, depends not only on its own qualities and characteristics, but also on the care given to the design of the installation as a whole, as well as it construction, lubrication and maintenance.

1. GENERAL DESIGN OF THE INSTALLATION

1.1. IN TRANSMISSION

- **The centreline of the sprockets** should be horizontal or have a small inclination to the horizontal.



Where the angle of inclination exceeds 60°, and where a vertical drive cannot be avoided, precautions must be taken to ensure proper chain-to-sprocket gearing on the power sprocket.

- **The tensioned strand of the chain** should preferably be on top.

- **The number of sprocket teeth** should be selected from the standard range whenever possible. The normal transmission range should not exceed 1:8. Allow for two chain drives in series for higher ratios. It is preferable if the number of sprocket teeth and the number of links are prime numbers.

- Provide shaft centre adjustment to ensure that the slack section of the chain is around 1% of the drive centres, provide a further 3% adjustment to compensate for chain wear.

- Initially, the chain will not require any tensioning. But in certain applications, reciprocating drive direction, frequent stop/start operations… it is necessary to have a tensioning force on the slack strand that does not exceed 10% of the driving force on the tight strand. This automatically adjusted or periodically regulated manually.

- When either the motor torque or the driven machine loading are irregular, in addition to providing a tensioning device on the slack strand, it may be necessary to mount a guiding device on the tight strand. This can be automatically adjusted or periodically regulated manually.

- When either the motor torque or the driven machine loading is irregular, in addition to providing a tensioning device on the slack strand, it may be necessary to mount a **guiding device** on the tight strand to control vibration.

- In general, it is preferable, despite introducing correcting coefficients into your calculations, to adhere to the basic principles already outlined. These include: drive shaft centres neither to short nor too long; a drive ratio of about 3:1; a drive sprocket having about 25 teeth; and ideally simplex chain, but if multiplex, with a minimum multiplicity.

1.2. LIFTING WITH LEAF CHAINS

- In cases where two or more chains work in parallel, the forces should be well distributed between them, generally by using **adjustable fixing clevices** to compensate for the dispersion of the chain length and the other tolerances in the installation.

- All the **fixing devices** (clevises, pins, compensator etc.) must have strength at least equal to that of the chain.

- It is preferable that the linear speed of the chain is less than 0.5 m/s.

- The **hardness of the rollers/wheels** should be able to resist wear caused be pivoting under the load of the chain plates at the moment of its arrival on the roller and when it leaves. As a guide, the hardness should be somewhere between 300 and 400HB.

- When using roller chains in lifting, please consult us. It is to be noted however, that in the majority of cases multiplex chains should be planned for.

1.3. CONVEYING

- Number of teeth per wheel.

Conveyor chains generally have a pitch large enough to enable accessories to fitted to plate, hence the designer will want to reduce the number of teeth on the wheels in order to limit it's dimensions. The polygonal effect becomes noticeable when the wheel contains 12 teeth or less, or perhaps more when the rotation speed is significantly high. For particular cases consult us.

- Adjustment of the Shaft Centre.

The shaft centre should be adjustable in order to make chain assembly simpler, to adjust the slack on a section of the chain, and it's tension, and finally so as to be able to keep up with the normal lengthening over the duration of its

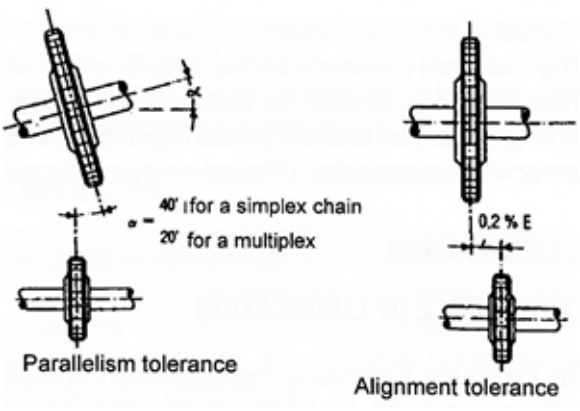
lifetime. A screwed tensioning device is usually used but automatic systems can equally be employed.

Warning: the chain must not be stretched; an excess of tension will lead to accelerated wear of the chain and eventually of the bearing surface. The tension force should not exceed 10% of the available force in the chain.

- Strand supports and guides

• The tensioned strand which generally carries the loads is supported by a guiding surface whilst sliding or rolling. Flanged rollers should be used when the shaft centre is large or when there is a transversal force.

• The Catenary strand can be supported by sliding because it is less loaded. The only case where no support is needed is when the circle pitch diameter is small, because then the Catenary force becomes prohibitive for the large pitch diameters. In any case, the slack should not exceed 0.4% of the shaft centre. This condition can result in a tension force that is too great, if the chain strand is not supported.



• Chain engagement of the two strands on the wheels should be carried out with extreme care: the railguide should be perfectly aligned with the teeth and should be rounded off at the end of the guide in order to facilitate chain entry.

2. DRIVE ASSEMBLY ACCURACY

2.1. IN TRANSMISSION

- Defects in shaft parallelism should be less than 40' for a simplex chain and 20' for multiple row chain.
- Sprockets must be less than 0.2% out of line on the shaft centres (fig.3). This limit falls to 0.1% for rapid transmissions. If it is not possible to avoid transverse shaft movement as happens in electric motor shaft "float", the sprockets must be aligned in the float position. Sprocket alignment is especially important for multiple strand chains because of their reduced transverse flexibility

The consequences of a defective quality of the geometry are:

• A noisy and vibrating transmission,
• A side wearing of the sprocket teeth and/or the chain inner plates,
• Stresses which may lead to the complete destruction of the chain,
• A wrong distribution of the forces of the chain plates when resistance and particularly fatigue limit can be considerably reduced.

- Sprocket teeth concentricity and run-out tolerances lie within limits laid down by the standard ISO606 and should not be altered be assembly (for example when keying a sprocket to a shaft).
- The rigidity of assembly should be such that sprocket alignment and shaft parallelism are not affected by driving forces of the chain when operating.

2.2. LIFTING

- Defects in the alignment and parallelism of fixing and reversing should be reduced as much as possible.

2.3. CONVEYING

- Defect in wheel alignment: 0.4% of the shaft centre.
- Defect in the parallelism of the tooth plan: < 40'
- The standard tolerance on the length of the chain which is 0.25%, should be reduced if 2 chains are working in parallel and are joined together with cross bars or with accessories. (Please notify us in your order).

3. LUBRICATION

3.1. THE ROLE OF LUBRICATION

- To introduce lubricating fluid between contacting surfaces (pin/bush, pin/plate; bush/roller, inner linkplate/outer linkplate etc.), to reduce wear and to avoid joint seizure.

- To protect the chain against corrosion.

- To reduce noise by introducing the lubricant between surfaces subject to shock loading.

- To transfer heat, generated by contacting moving components

3.2. FACTORY "LUB+" LUBRICATION ALLOWS:

- The chain to be protected against corrosion until it is installed by the user, provided it is not exposed to the elements. LUB+ remains effective six months for chains stored under shelter.

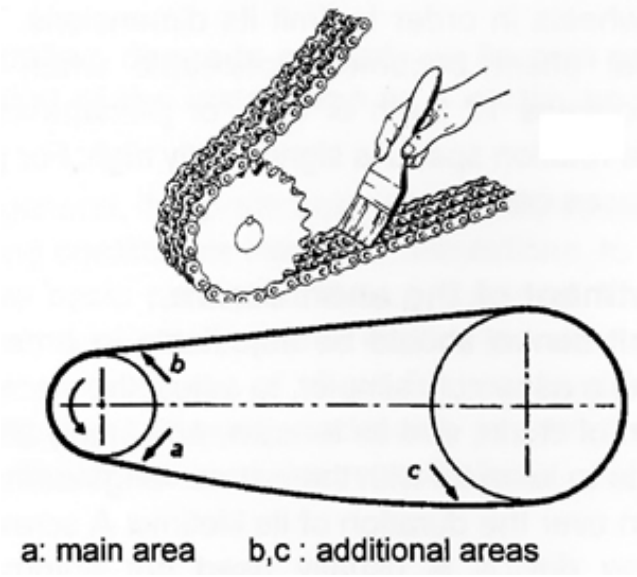
Pre-Lubrication with LUB+ should be complemented with lubrication by the users maintenance dept. as soon as the drive is started up. It should be noted that LUB+ is compatible with all mineral oils.

3.3. LUBRICATION METHOD

This should be chosen according to the criteria and characteristics of the installation, depending on its use. There are 4 main ways of applying lubrication:
1) Manual lubrication (by brush or oil can);
2) Continuous drip-feed lubrication.
3) Passing through a reservoir of oil in a chain case.
4) Pressure sprayed lubricant, with filtering and oil cooling.
In power transmission, any of these four methods can be used, although the choice depends on the type and speed of the chain.
When lifting or conveying, manual or continuous drip lubrication is usually employed although automatic brushes can equally be used.

3. 4. THE FREQUENCY OF APPLICATION AND QUANTITY USED SHOULD BE ESTABLISHED WITH CARE.

3.5. SITES OF LUBRICATION AS BELOW.



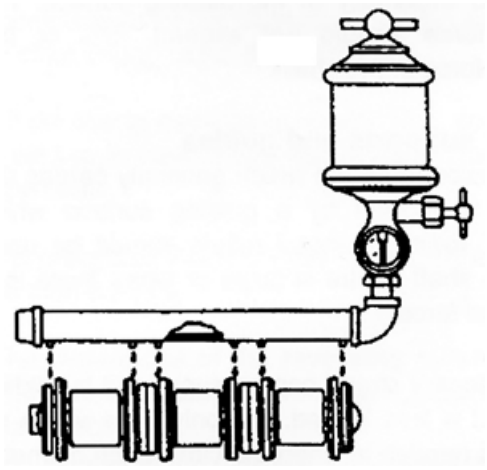
- Longitudinally in an area where the chain load is low in order to help the lubricant penetration.
- Transversally between the plates to feed the lubricant towards the joints and between the inner plates, the rollers and the wheels.

3.6. SUITABLE LUBRICANTS FOR OPERATING CONDITIONS.

In general a good quality clean straight oil, free from detergent is suitable. Its viscosity must suit the ambient temperature shown in the table hereafter.

Viscosity versus drive temperature

Temperature °C	Recommended viscosity grade : ISO-VG
-15<T≤0	15 to 32
0<T≤50	46 to 150
50<T≤80	220 to 320



The operator must achieve a compromise between a low viscosity lubricant which would centrifuge off the chain with properly lubricating it, and a substance with too high a viscosity, which would prevent the lubricant reaching contacting surfaces.
For special cases, and in particular where lubrication is not possible, please contact us.

• Unless recommended by us, the use of grease as a lubricant is wholly prohibited.

4. PRODUCT IMPLEMENTATION, SECURITY

4.1. STORAGE, HANDLING.

The storage of products before their assembly onto the installation should be such that their initial quality is retained. In particular, the following rules must be obeyed:

- Keep products away from a damp, corrosive or dusty atmosphere or where they may come into contact with harmful chemicals.
- Protect against mechanical damage or accidents.
- Do not exceed the stipulated storage period suitable with the original pre-lubrication protection.

The product should be handled with care, and operators should be advised on how to avoid it deterioration. In particular, shocks and forces applied perpendicular to the linkplates and can cause kinks in the chain.

4.2. ASSEMBLY

Before attaching the chain, it must be ensured that the quality of the installation conforms to the advice given hereabove. When all the checks have been made, set the chain length if required.

When assembling, the following safety rules should be obeyed:

- Wear safety glasses, safety gloves and safety shoes.

- Remove motor fuses, clamp motor starters of I.C. engines etc., to ensure no accidental premature start-up.
- Use suitable, good quality tools.

In addition, the following applies to all chain drive installations:

• Take care when unrolling the chain, not to twist it.
• Chains must be properly handled to protect it or some of it's components from loss or damage.
• Transverse forces during assembly must be controlled by guides to avoid deforming the chain.
• Place the connecting link on the slack strand and take notice to fit it the right way around.
• Do not fit a new link into a worn chain or a new chain onto worn sprockets.
• When a linkplate is damaged, replace it completely, and not just the damaged part. Change any link which may have been accidentally heated by a blowlamp or torch near the chain.

4.3. OPERATION

Before starting-up, check:
• The connecting link assembly, the fitting of the spring clip with the closed end pointing in the direction of chain travel, that nuts are properly tightened and that there are no stiff joints.
• The absence of nuts, tools and spanners on the chain or trapped in the chaincase.

Upon starting-up:
• Start off slowly and gradually, keeping a close watch during the first revolution or two.
• Run the drive under a light load or none at all for a while.
• Check the complete drive after a few hours or days of use.
• Check that the forces on the chain are like those in the calculations used for chain selection.

The state and position of the lubricant nozzles should be checked. The colour and degree of lubricant contamination enables the efficiency of the lubricant to be measured, and also whether it is sufficient and whether it should be renewed. If this is the case, apply once again or empty the installation using a lubricant of the same or superior quality.

First it is necessary to get rid of the lubricant and clean the chain in order to get rid of deposits of oil which could prevent the lubricant from penetrating the contacting surfaces.

5. MAINTENANCE

In a well assembled construction that is correctly lubricated, maintenance is restricted to ensuring that the whole assembly and lubrication methods remain satisfactory.

Periodical checks:
- The installation geometry, and particularly the sprocket alignment and tooth wear.
- The state of the chain, particularly to detect traces of rubbing indicating a geometrical failure or accidental structural contact and to assess the amount of wear:
• Wear of the joints is measured directly by its length (using a measuring instrument or a control ruler), either by appreciation or measurement of its slack or moving the tensioning device.
• Wear of the linkplates of leaf chains.
• Wear of the rollers and wheels.

Should the necessity arise, find out the cause of wear and rectify it. If it is necessary to change a sprocket or a chain due to excessive wear (more than 2% for the length of the chain, or more than 5% for the height of the plates), then it is better to change both the chain + sprockets or rollers together.

N.B.
Given the increased resistance of its components the chain is susceptible to being weakened by hydrogen.
Oxidising and corrosive environments must therefore be avoided.
An acidic environment is also to be avoided at all costs. The most stringent precautions should be taken when removing grease from the chain.
All superficial treatments to the chain and in particular electrolytic treatments, are to be avoided.