



## Harshwardhan Gupta's Design Tips-10

### Roller Chains

One of the sturdiest and cheapest forms of mechanical power transmission is the roller chain. The only thing cheaper than a roller chain drive is a plain flat belt. It is neither as efficient, nor positive. A V-belt drive would cost almost the same, if one designs, makes and installs it properly.

Roller chain, though the commonest, is only one type of many transmission or transport chains. Others are bush chains, conveyor drag chains, slat chains, etc...

Low costs aside, there are many pros and cons, and dos and don'ts with using roller chains. Some are common knowledge, others are not so commonly known. We will tackle them all here.

#### Advantages:

1. Low overall cost, as I said.
2. Easy to make and install even with primitive facilities.
3. Can tolerate a limited degree of misalignment – more than gears and timing belts but less than plain or Vee belts, both axial as well as angular – though it is not a good idea to let things go out of alignment.
4. Positive drive.
5. Can absorb a fair amount of shock loads.
6. Can go around many sprockets, on both sides of the chain path.

#### Disadvantages:

1. Needs a housing at high-speeds, unlike belts.
2. Noisy and fairly unsuitable at high speeds, unless completely enclosed, sealed and lubricated properly.
3. Needs adjustable CDs or jockey sprockets to tighten the inflexible chain.
4. Needs more careful alignments than V-belts.

#### Dos and Don'ts for designers:

1. Unless you are very sure of what you are doing, don't use a roller chain above about 500 rpm.
2. Always run chains almost without slack but not tight like belts, and not sagging like hammocks. Use either idler-tensioners or adjustable centers. Unlike timing belts, chain drives cannot be designed to assemble tightly on fixed center distances. This is important when the chains are almost vertical.
3. Do not harden sprockets if the running speeds are low. Nothing is gained by hardening for low-speed drives.
4. Always blackodize or phosphate the sprockets, especially if the chain remains idle on them for long stretches. Zinc or cadmium plating is okay in but do not nickel plate, electroless nickel, bright chrome, or hard-chrome the sprockets. If food-grade cleanliness is required, the roller chain is anyway the wrong idea! Use timing belts instead, or enclose the drive in an appropriately sealed housing.
5. Remember that standard roller chains are made and assembled on high-quality automatic machines; and non-standard chains, like conveyor drag chains, etc., are often made with cheap press-tools and manually assembled, resulting in serious pitch-errors, weak spots, heavy wear and tear, and high friction. In other

words, if you can do with standard chains with extended pins or extended leaves, do not use non-standard ones. I have seen some disastrous consequences of that.

6. Using sprockets of less than 17 teeth leads to vibrations in the chain and the shafts – invitation to fatigue failures – of chains, bearings, shafts, everything. Even idlers / tensioners should have at least 17 teeth.
7. It is not at all a good idea to use plain disks, or rubber rollers, or rubber shoes as tensioners.
8. It is also not a good idea to use spring-loaded tensioners – they may lead to excessive vibrations. Loading a chain tensioner with a tension- and not compression springs is inviting catastrophic failure. If the tension spring snaps, the chain will become a weapon of mass destruction. Tensioners are best adjusted and locked.
9. Just like belts, chains also need sufficient wrap to work well.
10. For fixed center distances, calculate the theoretical CD, and then reduce about 10% of the pitch, to get a nicely fitting chain. If you keep the distance exact, the chain ends will simply not come sufficiently close to assemble the lock.
11. Try and avoid offset links – they are manufactured very infrequently, and may not match the chain well. They literally are the weakest link.
12. Use multi-strand chains in place of bigger single-strand chains. However, these are more susceptible to misalignment.
13. Many sprocket manufacturers try to cut corners literally by using undersized blanks for the sprockets. This can be recognized by the presence of an excessive land on the crest of the teeth. Ideally, there should be no land whatsoever, but a small 0.5 to 1mm land is okay as a way to chamfer the sharp teeth. Anything more should be rejected.
14. I have seen many thin, large sprockets wobble sideways on their axes. This is just poor fitment and careless manufacturing / handling.
15. Chains can take a lot of abuse, but make sure there is no catastrophic accident if they fail.
16. Always assemble chains with locks. Do not join them by riveting to make them endless.
17. Chain drives – if properly designed and maintained – last long. Often the failure points in the whole drive are the bearings and keys, even shafts failing by fatigue failure. The usual reason is that the chain is often more over-designed than its companion components.

Dos and Don'ts for assemblers and users:

1. Do not assemble chains the way you do on a bicycle. Open the lock, wrap the chain and assemble the lock again.
2. Do not, repeat DO NOT lubricate roller chains with grease or viscous oil. Use a high-penetration lubricant like Singer Oil. The reason is simple: Lubrication in a roller chain is needed between the leaves, and between the pin, bush and roller. Only a low surface-tension, low-viscosity lubricant will reach there by capillary action. Grease and viscous oils only lubricate your mind into a false sense of security.
3. If the chain is operating in a dirty environment, grease it AFTER lubricating with high-penetration lubricant. However, in an abrasive environment, grease will abrade the chain even more. In such cases, put a fully closed guard.
4. Align the sprockets carefully. Better alignment directly means substantially longer life. The importance of this must really be understood.
5. Remember, when sprockets wear out, the chain starts riding higher and higher on the sprocket. So, if you can see a gap between the tooth root and the chain, the chain is worn out.
6. Always keep blackodized sprockets and chains well-oiled to avoid corrosion.
7. If a high-speed chain is making a whining / grinding noise, the sprocket teeth may be having an incorrect form, or there may be a slight angular misalignment.

8. If a low speed chain is making a random snapping noise, then either the sprockets are badly misaligned, or – more likely – the chain is too tight.
9. Discard a sprocket whose teeth have lost their symmetry even slightly. They are worn out! Don't wait till catastrophic failure.
10. If the slack side of the chain is continuously jumping up and down, it is too loose. If tightening does not correct it, the sprockets teeth may be eccentric with the bore.
11. May I remind all you gentlemen that the CLOSED end of the U-clip locking the chain must face the direction of running of the chain, not the open end?
12. In the sprocket, look for defective welding between the hub and the flange. Ideally, a sprocket should be one-piece. If it is welded, it must be stress-relieved properly.
13. Do not buy or use painted sprockets. They will ruin the chain and can hide welding defects.
14. While inspecting a chain, open the lock and unwrap it, soak the chain in kerosene and wash it thoroughly twice with fresh solvent, inspect it for wear, scuffing and fine cracks. If these are present, replace the whole chain, not parts.
15. Don't let chains rust even mildly. Rust pits are the starting points of fatigue cracks.

Chains are everywhere: Chain marketing, Chain snatching, Chain mail, Chain of stores, Chain of command, Chain reaction, Daisy-chains, Key-chains, To stop train pull chain... Chain maintain karo, aur chain kee neend sowo!

*Next Month: Fasteners, locks, split-clamps.*

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The author, Mr. Harshwardhan Gupta, is a graduate of I.I.T. Mumbai in mechanical engineering. He has been designing machines for the last 28 years, and has many World's First and India's First Machines to his credit. He is the founder of Neubauplan Machine Design Studio, an independent machine-design firm in 1981 in Pune. Suggestions for topics for future pieces, questions and comments can be sent to [neubauplan@eth.net](mailto:neubauplan@eth.net). Website [www.neubauplan.com](http://www.neubauplan.com).