Power transmission equipment

E-learning course transcript

Summary
This document provides a transcript of the audio narrative for this e-learning course.

SKF Knowledge Centre
In the event of queries please contact your local SKF representative, or
Email skfweb@skf.com

Web:ww.skf.com/group/index.html

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Introduction

Welcome to this introduction SKF power transmission equipment. We hope that you'll enjoy the course, and find it useful in your daily work.

1. About this course

1.1. Navigation tour

Let's begin by understanding how you can work your way through this course.

This course is divided into 4 modules.
You can move from module to module by clicking the links in the Modules menu bar.

Some modules are divided into lessons.
You can move from lesson to lesson by clicking the links in the Lessons menu bar.

You are currently looking at the "Navigation tour" lesson, in the "About this course" module. Your active selections are indicated by the blue items in the menu bars.

You can move from page to page within a lesson by using the "PREV" and "NEXT" buttons at bottom right of the player, and you can return directly to the start of the course at any time by clicking the "home" icon at top right of the page.

At top right of the player you will see a link from where you can download a transcript of the course narration.

You can use the audio controls at bottom left of the player to adjust the volume level of the audio soundtrack, or to pause the playback.

There is a timer display at the top of the player which allows you to monitor your progress through the course.

Learning online does not have to mean learning alone. If you have questions regarding the course content then you are invited to visit the "support module" where you will find links to our discussion forum and to our course tutors.

When you're ready to continue please select another lesson or module.

1.2. iPad users

If you'd like to access this course on an iPad then there are some special points that you should be aware of.

For Ipad users the course will play in the Articulate Mobile Player app, which is available free of charge from the app store.
The app's library function offers the option of downloading the course so that you can learn whilst off-line. Remember, though, that you need to be online to use the links on the course's "resources" tab, and if you want to obtain your course completion certificate then you'll need to be online when you take the end-of course-test.

1.3. Learning objectives (Interaction)

The course tuition is divided into five lessons.
Click the links on this page to view the learning objectives for each lesson.

1.3.1. Objectives - Lesson 1

After completing the "Basic principles" lesson you will be able to discuss (in the context of power transmission) the meaning of the following terms:

- Force and torque
- Work and energy
- Rotational and linear speed
- Resistance
- Power

You will be able to describe in general terms how to decide if a belt drive or chain drive is best suited to an application. You will also be able to explain the "speed ratio" between driving and driven shafts of a belt or chain drive.

1.3.2. Objectives - Lesson 2

In the "Timing belts" lesson you will learn how to recognise 3 basic belt types

1. Classical
2. Metric
3. HiTD / STS

You will be able to identify a standard timing belt from its SKF product designation.

You will be able to suggest solutions for seven common timing belt problems, using the troubleshooting guide provided.

1.3.3. Objectives - Lesson 3

In the "Wedge belts" lesson you will learn how to recognise 5 basic belt types:

1. Wrapped wedge and narrow wedge belts,
2. Cogged raw edge wedge and narrow wedge belts,
3. SKF Xtra power narrow wedge belts,
4. Wrapped classical belts,
5. Cogged raw edge classical belt

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You will be able to describe what is meant by the terms hex belts, banded belts and ribbed belts

You will be able to describe some best practices for storage of belts.
You will be able to discuss in general terms a number of areas relating to belt installation and maintenance including:

- Pulley inspection
- Belt installation
- Pulley alignment
- Belt tensioning methods and procedure.

You will be able to suggest solutions for seven common wedge belt problems, using the troubleshooting guide provided.

1.3.4. Objectives - Lesson 4

On completing the lesson about “Chains” you will be able to describe the construction of a roller chain, including the purpose of offset links and connecting links.
You will be able to identify chains of the of BS (ISO) and ANSI series from their measurements, and you will be able to identify a standard roller chain from its SKF product designation

You will be able to describe the 8 steps of a basic chain selection procedure, discuss 10 types of special chains, and the use of chain attachments.

You will also be able to briefly describe two types of automatic chain lubrication systems.

1.3.5. Objectives - Lesson 5

On completing the “couplings” lesson you will be able to discuss the basic features of rigid couplings and of universal joints.

You will also be able to discuss the characteristics and installation of 7 types of flexible coupling:

1. Grid couplings
2. Gear couplings
3. Flex couplings
4. Chain couplings
5. FRC couplings
6. Jaw couplings
7. Disc couplings

You will also be able to briefly discuss the importance of adequate coupling lubrication.

1.4. Test and certificate

At the end of the course you will be able to take a test, to check your understanding of the topics covered.

If you pass the test on-line, then you will be able to download and print your own course completion certificate.

You should save a copy of your certificate to a local drive. If you don’t then you’ll need to re-take the test if you later need to print an additional copy of the document.

2. Lessons

2.1. Lesson 1 - Basic principles

In the first lesson we’ll look at some basic principles that are applicable to all types of mechanical power transmission.

2.1.1. Terminology

Before we go into the details of the power transmission product range, we need to explain a few parameters such as force, torque, work and energy, rate, resistance and power. Please study the parameters on the screen before continuing to the next scene. Click on the respective terms for specific information.

2.1.2. Force and torque

Force can be described as a push or pull that causes objects to start moving, to move faster, to change direction, to slow down, to stop and / or to change shape. Forces may act in either a radial or axial direction. Torque is the effect of a force acting on an object at a distance from the axis of rotation; it is the product of the force and the radius at which it acts. Force (F) is measured in Newton (N) and torque is measured in Newton-metres (Nm).

2.1.3. Work and energy

Mechanical work is done when a force or a torque cause objects to move. Work is the product of the force (F) multiplied by the distance (s) through which the object is moved in metres. Work ¡s measured in Newton-metres (Nm).
Energy is the capacity to do work. Energy ¡s measured in joule (J) or Newton-metres (Nm) (1 J = 1 Nm).

2.1.4. Rotational and linear speed

Speed is the measure of how slow or how fast something moves with respect to time. In the context of power transmission, important terms are linear and rotational speed. Linear speed (v) is typically measured ¡n metres per second (m/s) whilst rotational speed (n) is typically measured in revolutions per minute (r/min).

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2.1.5. Resistance

Resistance is the opposite to motion. Friction, which is a type of mechanical resistance, occurs when one solid object slides over or against another. Friction is a function of the object's mass and of the coefficient of friction between the mass and the surface over which it moves. Mass is measured in kilograms, and resistance is measured in Newton (N).

2.1.6. Power

Mechanical power is described as the rate of doing work. For linear motion, power is a function of the force and the linear speed at which the object moves. For rotary motion, power is a function of the torque and the rotational speed. Power is measured in watt (W).

2.1.7. Belts vs chains

Chain drives can accommodate high torque, and moderate speeds. Belt drives can accommodate higher speeds, but relatively low torque.

2.1.8. Speed ratio

To illustrate the concept of power transmission, let's consider an electrical motor driving a pump. The driving pulley ¡s mounted on the output shaft of the power source, in this case the electrical motor. Torque is transmitted between the driving pulley and the belt via friction force.
In our example the electrical motor operates at a speed of 2800 rpm, but the pump needs to run at only 1400 rpm. So there is a ratio of 1:2 to drive the pump at the required speed. The solution would be to use a belt drive with a corresponding ratio of 1:2 between the diameters of the driving pulley (on the motor) and the driven pulley; in this example 150mm and 300 mm respectively.

2.1.9. Lesson summary

Before we move on let's summarize what we learned in this lesson.
We learned that power transmission involves a number of parameters such as force, torque, work, energy, rotational and linear speed, resistance and power. Typical power transmission applications include belt drives and chain drives; belts are typically used where speed is high but torque is low. There is a calculation tool available on www.skf.com to help you to specify belt and chain drives correctly.

2.2. Lesson 2 - Timing belts

In this lesson we will explore timing belts.

2.2.1. Timing belts

For timing belts (sometimes called "synchronous belts"), the drive comes from the leading edge of the belt tooth. This type of belt is considered to be a direct drive belt and the timing of the belts can be precisely matched enabling exact driven speeds to be calculated.

2.2.2. Belt types

Synchronous (timing) belts are found in a wide variety of precision drive applications such as robots, machine tools and car engines.
Timing belts are available as both classical timing belts and metric timing belts. High torque (HiTD) and Super torque (STS) belts are also available for more demanding applications. Double sided belts are also available.
Click on each type here for more detail.

2.2.3. Classical

Classical belts are available in various cross-sections; The range extends from MXL at the smallest end, to XXH for larger section belts. As an example, if you were to open a deskjet printer and examine the belt which is driving the ink cartridge holder then you would likely find an MXL or XL section timing belt.
All of the designations for classical timing belts are express dimensions in inches. Click on the "designations tab" for more information.

Here you see a typical designation for a single-sided, classical timing belt.
Its starts with PHG, which is the SKF designation for all belts.
Next comes the pitch length of the belt, expressed in one tenths of an inch.
Next we have the belt profile, and finally the width of the belt expressed in one hundredths of an inch.
The use of inch-based measurements can be confusing, so care is needed. At first sight 344 (for example" may be thought to represent 344mm, but it actually represents 34.4 inches (i.e. 874mm), so please take care when specifying classical timing belts.
Next we see a typical designation for a double-sided classical timing belt. Prefix, pitch length, section and width are expressed in the same way as for a single sided belt, but an additional "D" is introduced after the prefix to indicate that this belt is double sided.

2.2.4. Metric

The standard material for metric timing belts is nowadays polyeurethane thermoplastic, white or clear in colour, and with steel cords.

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Rubber belts, and glass fibre corded variants are available. Like classical belts, metric belts use a trapezoidal tooth profile.

Here we see a typical designation for a single sided metric belt.
Like classical belts these belts carry the PHG prefix, Next we see the belt section (in this case T5), followed by the pitch length of the belt expressed this time in millimetres. The designation is completed by adding the belt width, again expressed in millimetres.
For metric belts, the designation for a double sided belt works in similar fashion, but includes "DB" after the PHG prefix.

2.2.5. HiTD and STS

The high torque drive (HiTD) belt is a heavy duty synchronous belt for demanding applications. The HiTD belt is SKF's version of the well known HTD belt.
The HiTDs more robust tooth profile means that this belt has increased capacity in comparison to a standard timing belt.
Hi TD belts are available in a number of cross sections from 3M to 20M
STS or "Super torque series" belts have a slightly different tooth profile than the HiTD belts, and will not run on HiTD pulletys.
STS belts are available in sections S2M to S14M.

For HiTD belts the designation is straightforward. The SKF standard prefix for belts is PHG, followed by the pitch length of the belt expressed in millimetres. Next comes the belt profile, and finally the belt width, again expressed in millimetres.
Designations for double sided belts are similar, but with the addition of "DA" after the prefix, to indicate a double sided symmetric belt, and a "DB" to indicate an assymmetric double sided belt.
Designations for STS belts are a little different to HiTD designations.
The PHG prefix is followed by the belt section, then the pitch length in millimetres, and finally the belt width in millimetres. For a doublke sided belts the DA (symmetric) and DB (assymmetric) designations are added after the PHG suffix.

2.2.6. Installation and maintenance

Correct pulley alignment and belt tension will have a significant impact on belt life.
The amount of tension required is enough to ensure that the teeth on the belt correctly engage the sprocket teeth at the power required.
For a more detailed discussion of belt installation and maintenance procedures please see the "Installation and Maintenance" section of the "wedge belts" lesson

2.2.7. Lesson summary

In this lesson we learned about the three basic types of timing belt: classical, metric and HiTD / STS.
The SKF designation system for timing belts was explained, and a troubleshooting guide was provided to aid resolution of seven common timing belt problems.

2.3. Lesson 3 - Wedge belts

In lesson 3 we will consider wedge belts.

2.3.1. Wedge belts (V-belts)

For V-belt drives, the driving force of the belt comes from the contact between the walls of the pulley and the sides of the belt as they are pulled in and tensioned. V belt drives allow for a certain amount of belt slip between the belt and pulley and thus cannot be used where precise timing is required between driving and driven pulleys.

2.3.2. Belt construction

Both classical V and wedge type belts are typically available as either a "wrapped" type or a "cogged raw edge" type.
The wrapped type is the more traditional type of belt.
The cogged raw edge type can be used for pulleys with a smaller diameter. Another advantage of the cogged type is the slightly higher power rating. On the other hand, the cogged type can suffer from accumulation of dirt in dusty conditions with accelerated wear and reduced life as a consequence.
The various belt types share some common characteristics in terms of their construction.
Cushion rubber provides good adhesion between the tension members (cords) and the rubber cushion.
The tension cords are made from polyester yarn. Pre-loading the cords during their rubber impregnation process results in low stretch during operation.
The rubber cushion is fibre loaded, giving good transverse belt rigidity, and the wrapping material is a heavy duty industrial fabric.
Click the links to view the features of each of the listed belt types.

2.3.3. Wrapped wedge and narrow wedge Belts

SKF Wrapped wedge and Narrow Wedge Belts have been designed to accommodate all industrial applications and some agricultural machines.

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High transverse rigidity minimizes heat generation. Chloroprene rubberized wrapping fabric resists abrasion and is moderately oil-resistant.
These belts are suited to a temperature range from -35 to +65 °C, and are are anti-static in compliance with ISO 1813.

2.3.4. Cogged raw edge wedge and narrow wedge Belts

SKF Cogged Raw Edge Wedge and SKF Cogged Raw Edge Narrow Wedge Belts have been developed to handle all industrial applications. They combine high transverse rigidity with high flexibility, and are available in lengths up to 3,500mm, with longer lengths available on request. The operating temperature range is -30 to +75 °C, and they are suitable for use in tropical climates.

2.3.5. SKF Xtra Power wrapped wedge and narrow wedge belts

SKF Xtra Power Wrapped Wedge and SKF Xtra Power Narrow Wedge Belts have been designed to deliver up to 40% more power than standard wrapped belts. They are suitable for all kinds of industrial applications and some agricultural machines.
A fibre filled compound encases the tension members thus enabling the belts to accommodate higher dynamic loads without compromising flexibility.

2.3.6. Wrapped classical belts

SKF Wrapped Classical Belts have been developed to handle the majority of industrial applications and some agricultural machines. They can run on ISO wedge pulleys as well as on classical V-belt pulleys, and are suitable for V-flat drives (flywheel applications).

2.3.7. Cogged raw edge classical belts

SKF Cogged Raw Edge Classical Belts have been developed to handle the majority of industrial applications running on ISO wedge as well as on classical V-belt pulleys.
They are available in lengths up to 3,500 mm, with longer lengths available on request.

2.3.8. Standard belt profiles

Here we see the different belts in a cross section view.
The wedge belt is a similar but stronger belt compared to the classical V-belt. Therefore, fewer belts and lighter pulleys can be used resulting in reduced space and weight in the application. The narrow wedge belt is a standard wedge belt with a slightly different width to height ratio.
As you can see the wedge, classical and narrow wedge are quite close dimensionally. The SP wedge series is the development of the Classical section, with slightly stronger cord material, and deeper section for increased cord support.

2.3.9. Hex belts

A hex belt has the cross section of a double section classical V-belt. It is designed for applications in the textile industry and other situations where one or more of the driven pulleys will rotate in different directions.

2.3.10. Banded belts

Banded belts consist of belts joined together in a set of multiple strands. The number of belts in the band can vary between 2 and 6. Banded belts virtually eliminate the negative effects of vibrations and are typically used in applications with pulsating loads. The high stability of this type of belt helps prevent the belt turning over during operation, especially in drives with a long centre distance.

2.3.11. Ribbed belts

The ribbed belt resembles a flat belt, but with V-shaped ribs along the inside surface for increased friction force between the pulley and the belt. Ribbed belts require less energy to bend around the pulleys and can therefore transfer power more effectively to the driven pulley. Ribbed belts are also used in high speed applications up to 60 m/s depending on the section. Ribbed belts also find application in situations where space constraints mean that smaller pulley diameters are needed, for example in gym equipment and white goods.

2.3.12. Belt storage

Do not store belts on floors, unless in a suitable container. Moisture can damage the belts; dust and contamination can also affect the belt surface.
Do not store belts near windows which may permit exposure to sunlight.
Do not store directly under roof structure unless adequate heat shield is in place to defect radiated heat. Radiated heat from roofs can damage the rubber belts.
Do not store belts in the vicinity of transformers, electric motors, or other electrical devices which may generate ozone.
Avoid storing belts in areas with solvents or chemicals; these may damage the rubber materials.
Belts are normally stored in two different ways,

1. flat on their side on shelves or
2. hanging on pegs mounted on the wall.

Storing belts, flat on shelves, is the best way but requires more storage space.
If the “hanging” option is used, you need to make sure that the pegs are large enough to prevent deformation being caused by the belt’s weight.
Longer V-belts should be coiled in loops.

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If a long V-belt is hung uncoiled, then the belt may bend excessively under it's own weight, causing damage (especially if small pegs are used). Long belts should be coiled into loops, and the table here offers guidance for the number of loops required. Similar to other belt types, banded belts are best stored flat on shelves. However, if they are stored on large pegs on the wall, precautions should be taken to avoid deformation. Further, these belts are normally shipped in a "nested" configuration. It is recommended that the belts be stored in this manner as well. Nests are formed by laying a belt on its side on a flat surface and placing as many belts inside the first belt as possible without undue force.
When the nests are tight and stacked with each rotated 180° from the one below, they may be stacked without damage. Belts of this type over approximately 120 inches may be "rolled up" and tied for shipment. These rolls may be stacked for easy storage. Care should be taken to avoid a small bend radius which could damage the belts. Similarly, for timing belts sharp bends and crimping as well as excess weight on the belts should be avoided. For timing belts up to 3 000 mm length, SKF recommends storing them flat on shelves if possible in a "nested" configuration.

2.3.13. Installation and maintenance

All SKF V-belts are produced to be set free, in other words you can take any belt of the same designation from the shelf and put it on a multiple groove drive. Note that this comment does not apply to banded belts. Proper tensioning will compensate small length deviations and make all belts carry equal load on the drive. Before installing a new belt, there are some steps you can take that will help ensure a long service life.

- Never mix different brands or belt types on the same drive. Belt lengths can differ from one manufacturer to another and different materials can have significantly different values for the coefficient of thermal contraction. SKF also does not recommend mixing new and used belts as it may result in uneven load distribution and premature belt failure.
- Never force belts over the pulley edge, since this may damage the surface and initiate a crack, which will weaken the belt and cause premature belt failure. Properly slack off and take up the drive until belts are easily placed in the grooves.
- Do not rely on belt dressings to eliminate belt slippage. Belt dressings can temporarily increase friction between the belt and pulley. However, this is a temporary fix until the cause of slippage can be identified and corrected.

2.3.14. Pulley inspection

Start by inspecting the pulleys.

For V-belt drives:
Make sure that all pulley grooves are of the same size. Uneven wear of grooves causes belts running on different diameter levels in the pulley as shown in the illustration here.. That generates excessive slip of the belts on one side and bad effects similar to mismatched belts on the other side.
General advice is to briefly inspect pulleys at every belt change but closely inspect and consider puller replacement at every third belt change. An SKF pulley gauge (shown here) can be used to check pulley wear. Pulleys should be replaced when more than 0,8 mm is detected between template and groove.
For timing belt pulleys:
Check that pulleys are not worn. Inspect for erosion, which may be seen as pockets on the driving of the pulley as shown in the diagram at bottom right. Pulleys should be inspected every time a new belt is installed. They are consumable items and should be changed at the third belt installation or sooner if operating under severe conditions.

2.3.15. Motor movement

Move the motor in as far as possible by using the motor adjuster frame if fitted, or by loosening the motor bolts if the motor is on slots.
Don't use improper tools, such as a rigid lever or any other sharp instrument to mount a belt. This can damage the envelope, the teeth and / or the cords; damage to the pulley rims may also be caused.

2.3.16. Pulley alignment

Alignment of the pulleys has a significant effect on belt and pulley life.
Although the belt is a flexible object, and can accommodate some misalignment - the trade-off will be an accelerated wear rate.
SKF recommend checking the pulleys when the drive is tensioned, since this will indicate misalignment caused by shaft deflections.
Misalignment can occur in a number of ways, as illustrated here. Maximum allowable misalignment (angle θ on the diagram) is 0,3° or 5 mm per metre of centre distance. Values greater than those listed will reduce the belt service life and cause edge wear.
A straight edge can be used to check proper alignment, but a more precise approach, particularly over long distances, is to use an SKF Belt Alignment Tool, for example the TKBA40 system, shown here.

2.3.17. Belt tension

V-belts work on pressure against SIDE WALL - this pressure needs to be accurate for correct belt performance.

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Insufficient belt tension will cause the belt to slip, which consequently generates heat, high belt temperatures and premature ageing of the belt. Degradation of the rubber compound, caused by excessive heat, will have a significant impact on the service life of a belt.
When the tension is too high, the belt will not slip, but it will have a negative impact on the service life of the bearings and the belt.
The Belt and pulley life is directly related to tension procedure

- Drive cost is affected by the replacement cycle.
- Maintenance costs are affected by the premature failure of components.
- Production performance is affected by increased maintenance cycles.

2.3.18. Measuring strand tension

SKF experience suggests that in many cases

- Maintenance staff are not trained in proper tensioning procedures
- The calculation of required belt tension is not understood
- Machine production pressures often preclude time being allowed for proper drive setup

Four main methods are used globally for checking belt tension - all measure strand Tension.
Click on each method in the list here to learn more.

2.3.19. Force deflection

The SKF Pen Tester is available to determine the deflection force [kg] required to set and maintain V-belt tension.

1. First, measure the span length.
2. Position the bottom of the large O ring on the pen scale at the measured span length
3. Set the small O ring on the deflection force scale to zero
4. Place the tension tester squarely on one belt at the centre of the span length and apply downward force to the plunger until the bottom of the large O-ring is even with the next belt or with the bottom of a straight edge laid across the pulleys.
5. Remove the tension tester and read the force applied with the values given in the tables provided with the tool. The force should be between the minimum and the maximum shown. The maximum value shown is for new belts, which will allow for anticipated tension loss. Used belts should be maintained at the minimum values indicated in the tables.

2.3.20. Static tension tester

These SKF belt tension testers provide a simple way to determine belt tension. They are very useful in cases where no technical drive data is known which makes it impossible to calculate the appropriate tension. Tables provided give general tensioning values for a particular belt cross section in relation to the pulley diameter.
There are three testers (gauges) that cover most of the V-belt range:

- Gauge 1 - range: 15-70 kg
- Gauge 2 - range: 50-150 kg
- Gauge 3 - range: 150-300 kg

Having selected the appropriate tester:

1. With the indicator arm down, place the tester parallel to the side of one belt along the mid section of the span length.
2. Place your index finger in the rubber loop and press down on the belt.
3. Stop when you feel and hear the “click”.
4. Remove tester and read the belt tension by observing the point where the top surface of the indicator arm crosses the numbered scale on the tester body.

2.3.21. Natural frequency

The SKF Belt Frequency Meter is used for checking the tension by means of belt natural frequency measurements.
The Most accurate way to tension timing belts is via the clavis frequency method. Placing the head over or next to the belt and plucking like a guitar will allow the instrument to pick up vibrations
Tension measurements are presented in hertz [Hz] or in newton [N] if the drive parameters are entered.
This method offers a number of advantages:

- Precise and repeatable measurements
- Non-contact optical head with LED beam for easy pointing to belt surface
- Ease of use
- Wide tension range (10-400 Hz)
- Extremely fast response allows quick tension checks on multiple belt drives

The tool can be used in two different ways:

1. Technical data of the drive is not known and therefore the appropriate tension cannot be calculated. In such cases, refer to general tension values recommended for the particular belt in tables provided with the tool.
2. Drive data is known. The tensioning value can be calculated by the drive design program or by a belt tension formula. Simply measure the strand tension in the belt and compare it with the calculated value.

2.3.22. Elongation

Tension by elongation is accepted as an easy way to tension banded belts.
Using multiplier factors we can set the tension based on the elongation over any measurement.
Factors are:
Wedge - New 1.01 % used 0.75 %
Classical - New 0.75 % used is 0.5 %

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With belt loose draped over pulleys - measure circumference of belt.
Tension the belt, then measure the new circumference.
Compare to calculations - adjust if necessary

2.3.23. Belt tensioning procedure

Note that the data provided with the tensioning tools provides two settings; “NEW” and “USED”. Furthermore, different types of belts (wrapped, CRE and wrapped extra performance) have different requirements for the tension procedure.

- The adjustment times and tension amounts differ
- The applications can determine what type of belt is used
- Belt life is severely affected by any parts of the process missed

Click on the images here for more information

This is the best practice tension method for wrapped belts.
Ensure the belts are installed to the correct tension specifications for new belts (using the “new” tension value) - this value is applied to the tightest belt on the drive, not to all of the belts; in the case of multiple belt drives, there will be some variation in the tension of the individual belts.
Seat the belts correctly by rotating the drive about 5 times - recheck that tension remains correct and then run the drive.
Stop the drive after 2-24 hours after which time the tension will typically drop by 30-50% due to stretching of the cover wrapping.
Allow the belts to cool, then re-set the tension, this time using the “used” value. Again, apply the to the loosest belt on the drive - all others should be higher than this.
Run the drive again for 36-48 hours. During this period the drive will typically drop in tension again, this time due to elongation of the cords.
Again, stop the drive, allow the belts to cool, and then reset the tension using the “used” tension value as a minimum.
The drive should then work for 3-6 months without further maintenance.

For cogged raw edge belts, ensure the belts are installed to the correct tension specifications for new belts (using the “new” tension value) – this value is applied to the tightest belt on the drive, not to all of the belts; in the case of multiple belt drives, there will be some variation in the tension of the individual belts.
Seat the belts correctly by rotating the drive about 5 times – recheck that tension remains correct and then run the drive then run the drive.
After 24-48 hours running time the tension will typically drop by 30-50% due to due to elongation of the cords.
Stop the drive and allow the belts to cool, then re-set the tension to the “used” value. This value is applied to the loosest belt on the drive – all others should be higher than this.
Again, check that the belts are properly seated by rotating the drive 4 for five times. The drive should then be stable for 3 months or more without further maintenance. Tension should be checked at each maintenance period, and readjusted if necessary to “USED” value.

For extra power belts ensure the belts are installed to the correct tension specifications for new belts (using the “new” tension value) - this value is applied to the tightest belt on the drive, not to all of the belts; in the case of multiple belt drives, there will be some variation in the tension of the individual belts.
Seat the belts correctly by rotating the drive about 5 times - recheck that tension remains correct and then run the drive then run the drive.
After 2-24 hours running time the tension will typically drop by 30-50% due to due to elongation of the cords.
Stop the drive and allow the belts to cool, then re-set the tension to the “used” value. This value is applied to the loosest belt on the drive - all others should be higher than this.
Again, check that the belts are properly seated by rotating the drive 4 for five times. The drive should then be stable for 3 months or more without further maintenance.

2.3.24. Lesson summary

In this lesson we learned about the five basic types of wedge belt:

1. Wrapped wedge and narrow wedge,
2. Cogged raw edge wedge and narrow wedge belts,
3. SKF Xtra power narrow wedge,
4. Wrapped classical belts,
5. Cogged raw edge classical belt

Hex belts, banded belts and ribbed belts were also described.
Various aspects of belt installation and maintenance were discussed including

- Best practices for belt storage
- Pulley inspection
- Belt installation
- Pulley alignment
- Belt tensioning methods and procedure.

A troubleshooting guide was provided which suggests solutions for seven common wedge belt problems.

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2.4. Lesson 4 - Chains

In this lesson we will take a look at chain drives, and we'll start by looking at roller chains.

2.4.1. Roller chain - chain parts

SKF chains are manufactured in state of the art facilities with tight quality controls. All products conform to ISO standards and to other industrial standards like ANSI, BS, DIN and JIS. SKF Oil Field Chains are American Petroleum Institute (API) approved and each box carries the API monogram. SKF automotive chains meets the ISO/TS16949 Quality Assurance System technical specification. This specification aligns American (QS-9000), German (VDA6.1),French (EAQF) and the Italian (AVSQ) automotive quality system standards within the global automotive industry.
All SKF chains, with the exception of stainless steel, can accommodate temperatures from -20 to 150 °C. Stainless steel chains have a temperature range of -20 to 400 °C. For temperatures exceeding these values, alternative lubricants should be used. Note: For temperatures above 200 °C and below -20 °C, breaking load values are reduced. Apart from stainless steel chains, there are other anti-corrosion treatments and special coatings which are readily available upon request.
You can learn more about the components that make up a roller chain by clicking the numbered icons in the illustration here.

1. Pins are made from alloy steel that has been case hardened in rotary furnaces. These furnaces provide an even heat for a consistent and uniform case depth, which helps to resist damage from shock loads and to provide maximum wear resistance.
2. SKF chains use solid rollers that are cold-drawn from bar stock to improve fatigue strength and to resist the damaging effects of shock loads. All rollers go through a hardening process to improve wear resistance and increase service life. The rollers also undergo shot peening which significantly improves fatigue strength, and reduces cracking.
3. For the bushings, cold rolling provides a uniform wall thickness which is extremely important in achieving a precise and consistent pitch. Precision curling units offer a uniform bushing roundness, both inside and out, for an optimum bushing-link plate fit. Case hardening process provides the bushing with a wear-resistant case and a tough, impact resistant core. After heat treatment, the bushings are precision ground to improve service life.
4. The shape of inner and outer plates on SKF chains have been adapted to a wider-waist link plate design. This provides an increase in fatigue strength. By subjecting the raw material to a series of cold rolling processes and stringent thickness controls, the plates achieve uniform thicknesses which are critical for a smooth running chain. The plates endurance and strength is fully optimized by thru-hardening, shot peening and an aperture ball-burnishing process.

2.4.2. Connecting links and offset links

Connecting links are used to join two ends of a chain together. Both the spring clip and cotter pin type can be disassembled and replaced easily. The riveted type provides a stronger link, and has a similar fatigue strength as the other links in the chain.
Offset Links are used when an odd number of pitches are required in a chain. These Links consist of two cranked plates which are press fitted onto a bush and roller.
The wide end is placed over the last link in the chain and a connecting pin is installed and secured with a split pin.
It should be noted the use of the offset link de-rates the capacity of a standard transmission chain, particularly the use of the one pitch off-set link.
Off-set Links should avoided on higher speed applications, and on shock-loaded drives; They should only be used where set centres are required, and no other option is available.
Off-set links are NOT available for any of the heavy or super heavy series chains such as the H, SH, SHH or SPH range.

2.4.3. Chain standards

There are two main standards relating to roller chains.
ANSI or American standard chain was the first chain to be dimensionally standardized.
By using thicker side plates and larger diameter pins the British Standard series chains are generally higher tensile strength than ANSI chains. This is one major reason why the BS has survived against the ANSI in Europe and UK.
The worldwide sales of chain is biased towards ANSI at around 65% of the total production.
It should be noted that ANSI and BS chains cannot be joined together.

2.4.4. How to measure and identify

The various standards specify dimensions for all manufacturers.
By measuring these you can determine what series of chain you have. Particularly significant are the pitch, the roller diameter, and the distance between plates, as indicated here.
A single strand roller chain may sometimes be referred to as a simplex chain. Chains may consist of more than one strand joined together, as shown

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on the right here. There may be two (duplex chain), three (triplex) or even more stands.

2.4.5. SKF part numbers

SKF nomenclature for all chains has a defined prefix of PHC.
All standardized chains that we produce conform to conventional basic part number format.
The Roller chains designation format is constant through the range, with some examples shown here to indicate set up.
First, an example of the ANSI numbering system, which works as follows: The first number is the pitch size in 1/8 inch, in this example. 8/8 = 1 inch pitch. The second number refers to the chain being a roller chain, i.e. 0 = roller chain.
A number 5 replacing the 0 would indicate a bushing chain and number 1 indicates a narrower series.
The suffix, as with European standard chain, refers to the number of strands in the chain, that is in this case 1 = simplex (single strand) chain.
For a British Standard chain numbering system works as follows, The first two digits are the pitch size in 1/16 of an inch, therefore 08 = 8/16 or 1/2 inch. The letter B indicates the European standard. The suffix 2 indicates the number of strands in the chain, in this case a duplex (double strand) chain. i.e. 1/2 inch pitch duplex (double strand) chain would be 08B-2.
Remember that at first glance BS chains resemble American standard chains. Although they may be identical in pitch, there are other significant dimensional differences which distinguish them.

2.4.6. Basic chain selection procedure

Here is a basic procedure for the correct selection of a standard transmission chain, based on the guidelines and stated parameters given by the SKF Transmission Chains catalogue (publication 13747EN). Refer to the publication for more detail.
Establish the power (PM) to be transmitted.

1. Use kw for BS/DIN chains, or HP for ANSI series chains. If the actual demand power is unknown, then use the motor / prime-mover nameplate power.
2. Select the relevant Service Factor (Fa) for the application.
3. Select the relevant Service Factor (Fn) for the speed.
4. Multiply the power by the Service Factors to obtain the design power (Pd)….. the basis for chain selection. PD = PM x Fa x Fn (kW or HP)
5. Confirm the ratio of the sprockets required to obtain the final (driven) speed, by dividing the faster speed by the low rpm.
6. Select sprockets (Z1 and Z2) that will meet the ratio requirements. As a general rule start with the smaller sprocket (Z1) being 19T.
   - If the ratio is close to 1:1, try to use a larger number of teeth.
   - For the benefit of even wear, use odd number of teeth on at least one of the sprockets.
   - Avoid even numbers on both sprockets if possible.
7. Refer to the product catalogue and from either the BS / DIN (kW) tables or the ANSI (HP) select a chain that has sufficient or greater capacity than the design power (Pd) calculated earlier in step 3. Note that this selection is based on the faster sprocket speed (N1). Check the pitch diameters of the sprockets selected, either by reference to the product catalogue, or from the formula offered here. If the diameter is too large, consider a smaller pitch chain in multiple strands. A check should also be made of the hub capacity to accept the required finished bore.
8. Calculate the actual chain length (L) ensuring the shaft centres are between 30 and 80 pitches in length. Where possible the total chain length, including the connector, should be an even number of pitches, in order to avoid the use of an offset link.

2.4.7. Chain attachments

Roller chain attachments are commonly used in conveying applications or other cases where need exists to connect some other component to the moving chain.
Some examples of chain attachments are shown in the illustrations here on the left.
When ordering an attachments chain some extra detail is required. The shape of the attachment must be specified, whether the attachment should be on one side only, or on both sides of the chain, and also the spacing of the attachments (every link, every N links etc.) There are no global standards for chain attachments, beyond the basic chain dimensions.
SKF offers a range of chain attachments. Some of the most popular types can be viewed on the tabs here. Refer to product catalogues for full dimensional information.

2.4.8. Special chains

Click the links on the left of this page to explore a range of special chain types.

2.4.9. Corrosion resistant

Stainless steel chains have superior corrosion resistance for the most demanding applications. SKF offers a variety of such chains for applications where a high level of cleanliness is required or where harsh chemicals are used. SKF stainless steel chains are made from SS304 grade steel for

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high corrosion resistance and BS and ANSI standard chains are available. Chains made from SS316 and other stainless steel grades are available for higher temperature applications. The SS316 stainless steel is also somewhat more resistant to the effects of magnetic permeability, and harsher chemicals. These chains are suitable for food processing, pharmaceutical, high/low temp (-20 to 400 °C) and corrosive environments.
Nickel-plated roller chains combine the strength of standard roller chains with the corrosion resistant properties that come from the nickel-plating. Nickel-plating of all components prior to assembly promotes uniform coverage during the plating process. Nickel-plated chains are not suitable in applications that may involve contact with food.
Zinc-plated roller chains provide a very good adherence of the plating to the base metal and thus combines the strength of standard roller chains with the corrosion resistance that comes from zinc-plating. Once again, plating of all components prior to assembly promotes uniform coverage during the plating process. Zinc-plating is more cost-effective than nickel-plating, and zinc-plated chains are typically used in outdoor applications and where there is exposure to sea/salt water environments.
Dacrotizing is a process of metal coating. The compositions are proprietary water based coating dispersions containing metal oxides, metallic zinc and aluminium flakes. The zinc and aluminium platelets align themselves in multiple layers forming a metallic silver gray coating. Overlapping zinc and aluminium flakes provide an excellent protective barrier and the zinc corrodes to protect the steel. Due to the concentration of aluminum within the coating, the result is good bi-metallic corrosion resistance. Damaged areas in the coating will fill with zinc oxides and carbonates, thus repairing itself. The dacrotizing process can be applied to numerous types of chains. These chains are suitable for extremely corrosive environments without loss of strength.

2.4.10. Extra strength

Using tensile strength as the measure of a quality chain does not always provide a complete picture. While tensile strength is important to use in calculating the maximum chain pull, useful in lifting calculations, this does not always represent the fatigue life and performance of the chain.
The pattern of the work load is particularly complex in heavy drive environments where significant shock loads are present. This can lead to rapid elongation and chain failure. Therefore the SKF Xtra Strength Chain design includes, optimized hardness of the material, precision fit of the components as well as an overall size increase of the parts. This will in turn provide a much longer service life for the chain in demanding drive conditions.
SKF Xtra Strength SH Chains have a 25-35% greater ultimate tensile strength than ANSI heavy duty roller chains due to their thicker plates and thru hardened pins. These chains can accommodate higher shock loads and provide longer service life, while retaining the same dimensions as ANSI heavy duty series roller chains.
SKF Xtra Strength SPH Chains have specially designed, close tolerance link plates and pitch holes. Their special design can improve load carrying capacity by 25-32%. The pins used on these chains are thru hardened for greater shock load resistance. The dimensions of these chains are the same as ANSI standard roller chains.
SKF Xtra Strength SHH Chains use link plates that, in most cases, are equal in thickness to the plates used in the next larger size of SKF Xtra Strength SPH Chains. The pins are also thru hardened. The use of higher grade materials results in chains that have greater ultimate tensile strength and allowable load than SKF Xtra Strength SH Chains.

2.4.11. Extra performance

The method of achieving internal lubrication of the chains is known as sintering and consists of the high quality oil impregnation of the components during their manufacture. The steel bushings are forged with lubricant within the material structure of the steel. During this operation, the lubricant forms a micro thin layer between the pin and internal roller surfaces.
Self-lubricating chains provide excellent service life without relubrication. In addition, self-lubricating chain pins are nickel-plated to provide a very smooth running surface that will not cause the selflubricating bushings to wear. The link plates are black phosphate coated. Self-lubricating chains are interchangeable with standard roller chains. The use of self-lubricating chains can substantially reduce elongation in many applications. This provides an increased service life of the chain. The SKF Xtra Performance SLR Chains can also be used as a base for attachment chains, which are commonly required in the printing and packaging industry.
As self-lubricating chains do not require lubricant, they are suitable for applications where lubrication is not possible or practical. Consequently, these chains offer a long-lasting maintenance- free solution. Contamination of the final product from oil spillage or oil mist is the primary reason for lubrication-free chains in the paper, packaging, electronics, white and brown goods manufacturing sectors. Altogether, if lubrication can be avoided, planned lubrication intervals are unnecessary and maintenance costs are reduced accordingly.

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2.4.12. Side bow

Side bow (curved) chains are able to flex and twist due to extra clearance between the inner and outer side plates. They are ideal for use on curved conveyors or to transmit power under misaligned sprocket conditions. They are produced with barrel shaped pins and greater pin, bushing and link plate clearances. These features allow the chain to travel in a curved path and/or to twist. SKF Side Bow Chains are commonly used in curved track conveyors in bottling, packaging, canning and textile applications.

2.4.13. Hollow pin

SKF Hollow Pin Chains offer flexibility to end-users as cross rods or extended pins may be easily inserted. They are ideal for applications where the spacing of cross rods or pins must be changed frequently. Hollow pin chains are available in carbon steel and stainless steel.

2.4.14. Straight sideplates

SKF Straight Side Plate Chains possess flat, rather than contoured link plates, which gives them better sliding properties in conveyor applications. The fatigue strength and chain weight are slightly higher than for standard chains.

2.4.15. Double pitch

SKF Double Pitch Roller Chains are produced in accordance American roller chain standards. In general, these chains are dimensionally similar to ASME/ANSI standard products except that the chain pitch is doubled. They are available in both transmission and conveyor types with standard sized rollers, and additionally in the conveyor series with large (oversize) rollers. These chains are an economical choice for low speeds, moderate loads, and long centre distance drive applications including a variety of conveyor systems and material handling equipment.
The SKF agricultural chains are used extensively in the general agricultural industry for either light duty drive chains, or with a range of optional attachments, (typically K and A types) are used for conveyor drives and elevators. Applications may include combined harvesters, grain elevators, grading machines, and balers, amongst others. They may also be used on light duty elevator applications. The SKF series interchanges with the industry standards in use today. Special treatments such as zinc plating are available on request.

2.4.16. Oil field chains

SKF Oil Field Chains are used in oil industry applications where extreme loads and harsh operating conditions occur. These chains are manufactured according to API specifications and are designed to withstand heavy shock loads and extreme drive conditions. Installation and maintenance are easy and simple. Oil field chains have distinctive “crook shank” pins to allow for easy assembly and dismantling.

2.4.17. Silent chains

Silent chains (inverted tooth chains) are made up of stacked rows of flat, tooth shaped driving links that mesh with sprockets having compatible tooth spaces, similar to a rack and pinion mesh. Typically, chains will also contain guide links, whose purpose is to maintain proper tracking of the chain on the sprockets. Washers or spacers may be present in some chain constructions. All of these components are held together by riveted pins located at each chain joint end. Pin and rocker joint design minimizes heat and allows for low wear rates during power transmission. These chains transmit power smoothly, efficiently and economically.
SKF Silent Chains are manufactured to comply with GB10855 (equivalent to SC Series silent chains in ANSI B29.2M), which are most commonly used for industrial applications.
SKF Silent Chains offer unique advantages and options in both power transmission and conveying applications. In power transmission applications, silent chains are capable of transmitting loads and speeds that exceed the capability of all other chains and belts. Drives are compact and efficient, operating with little noise or vibration. In conveying applications, silent chains provide a durable, heat resistant, non-slip, flat, conveying surface that runs with a nearly constant linear velocity.

2.4.18. Leaf chains

SKF Leaf Chains are designed for high load, slow speed tension linkage applications. Often, they are specified for reciprocating motion lifting devices such as forklifts or as counterweight chains for elevators or telescoping equipment, e.g. cranes. The chains are typically supplied in a specific length and connected to a clevis at each end. The clevis may accommodate “male” ends (inside links) or “female” ends (outside links), as required. A chain with an even number of pitches has one male and one female end. A chain with an odd number of pitches have either two male or two female ends. SKF Leaf Chains are available in series: AL, BL, LL, FL, 12XX, 15XX, 19XX and 25XX. BL series leaf chains are made according to the American standard ASME/ANSI B29.8. LL series leaf chains are made in accordance with the ISO 606 international standard. The applications for these chains include counterweight chain for masts, elevator and oven doors, forklift truck masts, spinning frames and any other lifting or balancing applications.

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2.4.19. Chain lubrication

SKF Power Transmission and SKF Maintenance Products together help you mount, lubricate, align and maintain your application more efficiently.
SKF Chain oils come in three convenient sizes to suit the needs of most chain applications in industrial environments. The chain oils - medium temperature, high temperature and food compatible (NSF H1) - are available in 400 ml (13,52 oz.) aerosol cans, 5 liter (1,32 gallon) cans, and as an oil fill for SYSTEM 24® single point automatic lubricators.
SKF can also recommend the right oil projection system for specific application needs. SKF ChainLube oil projection systems can be set up with the right grade and type of chain lubricant to suit the application; for example low temperature and humid environments, or with food grade lubricant among others. Click the tabs for more information.

2.4.20. Lesson summary

This lesson described the construction of roller chains, including the use of connecting links and offset links. We learned how to identify chains of the BS and ANSI series from measurements taken, and the SKF product designation system for roller chains was explained.
A basic 8-step procedure for roller chain selection was described.
Ten types of special chain were described, and the use of chain attachments was discussed. The lesson finished with a brief look at two types of automatic chain lubrication systems.

2.5. Lesson 5 - Couplings

In this final lesson we will take a look at shaft couplings.

2.5.1. Introduction

Shaft couplings are devices used to mechanically connect two shafts, in order to transmit power from one shaft to the other.
Flexible shaft couplings are also able to compensate for shaft misalignment in a torsionally rigid way. Misalignment can be angular, parallel or skew. This is particularly important for applications where misalignment could affect the velocity and acceleration of the driven shaft. The performance of the coupling depends largely upon how it is installed, aligned and maintained.

2.5.2. Coupling types

SKF supplies a selection of coupling types to suit a wide range of applications.
Some of the SKF coupling types are shown here.
Click on the links here to explore each type in more detail.

2.5.3. Rigid couplings

For rigid couplings, the transmittable torque is usually determined by the shaft diameter rather than by the coupling.
Although rigid couplings typically employ few components, ease of installation is usually considered to be poor, due to the need for accurate shaft alignment, which is often time-consuming.

2.5.4. Universal joints

Universal joints, also known as pin and block couplings, are commonly used to satisfy low to medium torque requirements in industrial, off-road and agricultural applications.
These couplings offer an economical solution for applications up to 1,800 r/min and will provide working angles of up to 25° or 35° for manual drives.
SKF offers these couplings with a solid bore from stock, bored to size. Square, hexagonal and round bores are available on request. The couplings are available in either a single (UJMA) or double (UJMB) configuration.

2.5.5. Grid couplings - introduction

The grid coupling is a typical general purpose coupling.
It consists of 2 hubs of alloy steel, precision machined with multiple slots into which a steel grid is firmly fitted.
The grid is of high strength alloy steel, tempered to spring steel quality, and shot peened for stress relief.
A cover is provided to contain lubricant, to prevent contamination and as a safety support.
Parallel and angular misalignment as well as end float is taken up by sliding movement of the grid.
The slots are generally tapered to allow the grid to flex.
The grid coupling offers protection against impacts and it cushions shock loads very well. It also dampens vibrations and it is ideal for applications where space is limited. Another advantage is that it is very easy to replace the grid, which is the wearable part of the coupling.
Click on the flashing icon for more information.
There are two versions of the grid coupling, having a horizontal split cover or a vertical split cover.
Horizontal split covers are made of aluminium.
They allow easy installation, and easy inspection of the coupling in situation. With horizontal covers it is easy to replace grids in situation, with less requirement to change any alignment settings.
Horizontal split covers employ nitrile seals for grease retention and dust exclusion.
Vertical split covers are of pressed steel construction. They offer that same power capacity

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as horizontal split covers, but can support up to 20-30% higher speed, depending upon coupling size.

2.5.6. Grid couplings - operation

The bending of the spring steel element as load increases means that for light loads the contact area is small. The contact area increases as the load increases.
As the contact area increases the distance for load centre decreases resulting in lower shearing forces, increasing the coupling's ability to resist shock loads.
The use of a spring steel element also provides vibration damping by as much as 30%. Lower vibration means reduced stress on machine parts with implications for component life extension.

2.5.7. Grid coupling - brake

This illustration shows a Grid type brake coupling which serves a dual prupose. It couples the drive to the shaft, and also to the safety / actuating brake. The design accommodates the same power as a normal coupling. The brake unit capacity is determined by the drive and coupling safety design factor.
Typical applications for couplings such as these include cranes, winches and trolleys.

2.5.8. Grid couplings - Installation

SKF Grid Couplings are designed to operate in either a horizontal or a vertical position without modification.
The performance of the coupling depends largely upon how it is installed, aligned and maintained.
Click on the process steps for more information

1. Clean all metal parts using non-flammable solvent. Check hubs, shafts and keyways for burrs and remove if necessary. Lightly coat the seals with grease and place well back on the shafts before mounting the hubs. Mount the hubs on their respective shafts so that each hub face is flush with the end of the shafts.

2. Using a feeler gauge equal in thickness to the gap specified in the catalogue, insert the gauge as shown in the image to the same depth at 90° intervals and measure the clearance between the gauge and hub face. The difference in the minimum and the maximum measurements must not exceed specified angular limits.

3. Align the two hubs so that a straight edge rests squarely on both hubs and also at 90° intervals. The clearance must not exceed the parallel offset installation limits specified in the catalogue. Tighten all foundation bolts and repeat steps 2 and 3. Realign the application if necessary.

4. Pack the gap and all of the grooves in the two hubs with a specified lubricant before mounting the grid. As with gear couplings it is very important to use the correct type of grease, as standard greases will separate due to centrifugal force at higher speeds. SKF recommends the SKF Coupling grease LMCG1. Fit the grid over the hubs by starting at one cut end, work the coils of the grid tooth by tooth in one direction and seat firmly as you go with a soft mallet.

5. Pack the spaces between and around the grid with as much lubricant as possible and wipe off the excess so that it is flush with the top of the grid. Position the seals on hubs so they line up with the grooves in the cover.

6. Position gaskets on the flanges of the lower cover half and assemble the covers so that the match marks are on the same side.

7. Push gaskets in until they stop against the seals and secure cover halves with the fasteners provided and tighten them accordingly. Make sure that the gaskets stay in position during this tightening procedure.

8. Once the coupling is completely assembled, remove both of the lubrication plugs in the cover and insert a lubrication fitting. Then, pump in the appropriate lubricant until it is forced out of the opposite lubrication hole. Replace the two lubrication plugs and the installation is complete.

9. Whenever it is necessary to replace the grid, first remove the cover halves and set aside. Beginning at the cut end of the grid, carefully insert a screwdriver into the loop. Using the hub teeth for leverage, gradually pry the grid up, alternating sides while working around the coupling. SKF does not recommend re-using the removed grid.

2.5.9. Gear couplings - Introduction

Gear couplings come in many variants, some of which you see here. Although some will be discussed briefly during this lesson, a full description of all of these is outside the scope of this training, so please refer to the catalogue for more information.
Gear couplings have a high load capacity, they can accommodate large shaft diameters, and also have

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a high torque capacity. Gear couplings are also flexible.

2.5.10. Gear couplings - Construction

The gear coupling consists of two identical hubs with gear teeth, which mesh with corresponding teeth in the covers, and that is how the power is transferred from one shaft to the other. This gear arrangement can accommodate a certain amount of parallel, angular and axial movement.
Gear couplings are capable of extreme torques at high speeds (up to 8,000 rpm).
Gear couplings typically come in two main variants, called “Single engagement” and “double engagement”
At the top here we see a typical single engagement coupling.The “rigid hub” includes no gears, and is rigidly attached to one shaft (typically bolted or shrink-fit). The flexible hub, mounted on the other shaft, includes the gears.
A double engagement coupling, depicted in the lower illustration employs two flex bubs, and so can accommodate a little more misalignment and axial movement.

2.5.11. Gear couplings - Tooth profile

For the SKF AGMA compliant gear couplings, the main difference between brands is tooth size and profile. The SKF triple crowned tooth has stress relief across all planes and the triple crowned tooth profile allows the hub to align in the cover both horizontally and vertically.
SKF is NOT interchangeable with other brand covers due to dimensional differences.

2.5.12. Gear couplings - Installation

Correct installation is important for optimum coupling performance and service life. Click on the process steps here to learn more about how to install a gear coupling.

1. Clean all metal parts using non-flammable solvent and check hubs, shafts and keyways for burrs and remove if necessary. Lightly coat the seals with grease and place well back on the shafts before mounting the hubs. Optionally both shafts can be lubricated with light oil or an antiseize compound. Mount the hubs on their respective shafts so that each hub face is flush with the end of the shaft unless otherwise indicated.
2. Use a feeler gauge equal in thickness to the gap specified in the catalogue. Insert the gauge as shown in image to the same depth at 90° intervals and measure the clearance between the gauge and hub face. The difference in the minimum and the maximum measurements must not exceed specified angular limits.
3. Align the two hubs so that a straight edge rests squarely on both hubs as in image, and also at 90° intervals. The clearance must not exceed the parallel offset installation limits specified in the catalogue.
4. Tighten all foundation bolts and repeat steps 2 and 3. Realign the coupling if necessary.
5. Pack the gears of the hubs with grease. Insert the gasket between the sleeves and position the sleeves with the lubrication holes approximately 90° apart. Then push the sleeves into position and using the supplied fasteners, bolt the sleeves together. Once the coupling is assembled, remove the lubrication plugs from the sleeves. Insert a grease fitting in one of the holes and pump grease into the sleeve until it is forced out of the opposite lubrication holes. Replace the lubrication plugs. s with grid couplings it is very important to use the correct type of grease, as standard greases will tend to separate due to centrifugal force at higher speeds. SKF recommends the SKF Coupling grease LMCG1.

Once the coupling has been properly lubricated, installation is complete.

2.5.13. Gear couplings - Special types

Click on the links here to explore some gear coupling variants.

2.5.14. SKF Flex couplings

SKF Flex Couplings are designed to accommodate misalignment and shock loads and to dampen vibration levels. These easy to install, maintenance-free couplings are available with either a machined-to-size bore, or with a taper bush ready bore. Couplings with a tapered bore can be Face (F) mounted or Hub (H) mounted. The more versatile Reversible (R) design can be either face or hub mounted depending on the application. These couplings are also available with a taper bushing.
SKF Flex Couplings consist of 2 flanges and 1 tyre. The flanges are phosphate coated for improved corrosion resistance. A standard sized spacer flange can be added in applications where it is advantageous to move either shaft axially without disturbing either driving or driven machines.
SKF Flex tyres are available in natural rubber compounds for applications ranging from -50 to +50 °C. Chloroprene rubber compounds should be used in applications where exposure to greases and oils are likely. These compounds can accommodate temperatures ranging from -15 to +70 °C. The chloroprene tyres should be used where fire-resistance and anti-static (F.R.A.S.) properties are required.

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2.5.15. Coupling spacer

The SKF Flex coupling spacer is used to join two shaft ends that cannot be positioned close enough to just use a coupling alone.
The spacer also allows removal of a shaft without the need to move either the driving or the driven machine. For example, this allows easy and fast replacement of impellers in pump applications.

2.5.16. SKF Flex couplings - installation

All metal components should be cleaned. Be sure to remove the protective coating on the flange bores. The taper bushings should be placed into the flanges and the screws lightly tightened.

1. If internal clamping rings are being used (size 40-60), position them onto the shaft.
2. Place the flanges next to the clamping ring on each shaft and position them so that dimension M (see table in catalogue) is obtained between the flange faces. Where taper bushings are used, then you should refer to the separate fitting instructions supplied with the taper bushings. Flanges with external clamping rings (sizes 70-250) should have the clamping rings fitted when installing, engaging only two or three of the threads of each screw at this time. These flanges should be positioned so that M is obtained by measuring the gap between the flange faces.
3. Parallel alignment should be checked by placing a straight edge across the flanges at various points around the circumference. Angular alignment is checked by measuring the gap between the flanges at several positions around the circumference. Align the coupling as accurately as possible, particularly on high-speed applications.
4. Spread the tyre side walls apart and fit over the coupling flanges, making sure that the tyre beads seat properly on the flanges and clamping rings. To make sure that the tyre sits properly in position, it may be necessary to strike the outside diameter of the tyre with a small mallet.
5. When the tyre is correctly positioned there should be a gap between the ends of the tyre.
   - For couplings F40-F60 the gap should be 2mm
   - For couplings F70-F120 the gap should be 3mm
   - For couplings F140 and F160 the gap should be 5mm
   - For couplings F180-F250 the gap should be 6mm
6. Now, refer to the catalogue to determine the correct torque, and tighten clamping ring screws alternately and evenly (half turn at a time), working round each flange until the required screw torque is achieved.

2.5.17. Chain couplings - introduction

Chain couplings use a duplex roller chain as the coupling medium. The coupling will disconnect if the chain breaks, and so is non-failsafe. The chain can be replaced without need to move the motor or driven machine, so no re-alignment is necessary. Chain couplings are able to transmit higher torque than their shafts, making them ideal for high torque applications. Available with a pilot bore, finished bore or taper bushing, flanges are linked together with duplex roller chains enabling them to accommodate up to 2° of misalignment.
To help provide maximum service life and reliability, particularly for high speed applications, SKF recommends fitting all chain couplings with a cover and lubricating them properly. If a chain coupling is to be subjected to reversing operations, shock or pulsating loads, or other severe operating conditions, then select a coupling one size larger than normal.

2.5.18. Chain couplings - installation

Before commencing installation, clean all metal parts using non-flammable solvent and check hubs, shafts and keyways for burrs and remove if necessary.

1. Mount the oil seal rings on the sprocket hubs. Install the sprocket hubs flush with the end of the shafts.
2. Next, check the shaft alignment. Check the angular alignment by measuring the gap at various intervals around the coupling, and adjust to the “C” dimension specified in the product table in the catalogue. The measurement must not exceed the allowable angular misalignment.
3. Check the parallel misalignment by resting a straight edge squarely on both hubs. Repeat this at 90° intervals. Clearance must not exceed allowable offset misalignment of 2% of the chain pitch. Tighten all foundation bolts and repeat steps 2 and 3. Realign the coupling if necessary.
4. Lubricate the chain with grease. Wrap the chain around the two sprocket hubs and fix with the pin.
5. Fill the cover halves with grease, insert the gaskets, and install the cover to complete the installation

2.5.19. FRC couplings - introduction

FRC couplings and jaw couplings work on the same principle, employing interlocking jaws on each of the hubs. The space between supports an

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elastomeric insert or element. The elastic properties of the element provide the ability to handle misalignment, shock loads, and vibration. Shaft connections are “fail safe” due to their interlocking jaw design.
FRC couplings are designed as a general purpose coupling and employ an element having pods with an oval profile which gives this coupling type a higher load capacity than jaw couplings. They are able to cushion moderate shock loads, to dampen low levels of vibration and to accommodate incidental misalignment.
FRC couplings offer a range of hubs and elements, and are available with a pilot bore, finished bore or taper bushing (face or hub) to make installation quick and simple. FRC couplings are phosphate coated for improved corrosion resistance and are available with fire-resistant and anti-static elements (F.R.A.S.).
Fully machined outside surfaces allow alignment with a simple straight edge.

2.5.20. FRC couplings - installation

Let’s look now at how to install an FRC coupling. Click on the process steps.

1. Place the couplings on their shafts so that shaft ends do not protrude into the internal section of the coupling. Then tighten the screws on the taper bushing to the torque values given in the mounting instructions.
2. Insert the coupling element into one side of the coupling.
3. Move the other coupling into position and connect the two halves.
4. Check that the assembled length is correct.
5. Check angular misalignment by measuring the assembled length in four positions at 90° around the coupling. Then check for parallel misalignment using a straight edge across the length of the coupling flange. Allowable angular misalignment for all FRC couplings is 1°. Allowable parallel misalignment for FRC couplings is based on size (see catalogue for details).

2.5.21. Jaw couplings - introduction

Jaw couplings provide a cost-effective solution for standard power applications, cushioning moderate shock loads and dampening low vibration levels. Maintenance-free and easy to install, jaw couplings are also available with a “snap wrap” element which allows element replacement in situ.
Urethane and hytrel elements have a greater power rating than nitrile elements and are recommended for applications where a compact, high torque solution is required.

2.5.22. Jaw couplings - spacer unit

Where a snap-wrap element is used then it is usually secured with a steel retainer. Jaw couplings can also be used with a spacer unit.

2.5.23. Jaw couplings - installation

Installation of a jaw coupling is a simple process. Click on the process steps to learn more.

1. Place each coupling on its shaft so that shaft ends do not protrude into the internal section of the coupling . Then tighten the set screws.
2. Insert the coupling element into one side of the coupling.
3. Move the other coupling side into position and connect the two halves
4. Check that the assembled length is correct.
5. Check the angular misalignment by checking the assembled length in four positions at 90° around the coupling. Check parallel misalignment using a straight edge across the length of the coupling flange. Allowable angular misalignment for all jaw couplings is 1°. Allowable parallel misalignment for all jaw couplings is 0,38 mm. For most consistent results, check across at least 3 of the 6 points where the rubber elements are visible between the flanges.

2.5.24. Disc coupling – construction

The disc coupling consists of two steel hubs connected by a series of fitted bolts to a laminated disc, made from stainless steel.
There are 3 main series, being 4 bolt, 6 bolt and 8 bolt design, depending on the required torque and shaft diameter requirements.
The design may be single disc pack (angular misalignment only) or double disc pack (which will accommodate both angular and parallel offset.
The coupling has a phosphated finish for corrosion protection.

2.5.25. Disc coupling – features

Due to its design, the disc coupling has a number of advantages over those of other metallic couplings; it requires no lubrication, it is torsionally rigid (zero backlash) and is capable of operating over a wide temperature range.

2.5.26. Disc coupling – variants

Due to its torsional rigidity the disc coupling is ideal for high speed and floating shaft applications.
For longer shafts, a check needs to be done on critical speeds and couplings may need to be dynamically balanced.

2.5.27. Disc couplings - installation

Clean all metal components. Remove burrs from flange bores and ensure keyways are clean.

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1. When the distance between the ends of the shaft is less than the catalogue value for “G”, adjust the flange placement on the shaft to recommended dimension “G”. This can be done by projecting the shaft. If shaft projection into the element zone is required, please refer to the catalogue for maximum diameter for each size element. The maximum projection for shafts larger than the stated allowance is listed in the catalogue as dimension “S”. The projections ensure that the shaft does not interfere with the disc element.
2. To conduct an angular misalignment check, fix the dial gauge on one hub and rotate the hub to find the minimum reading. Then set the gauge to zero. Take extra care to measure the deflection away from the through holes, as they may be slightly distorted from machine work. Check deflection at the smoothest unbroken area. Refer to catalogue tables for deflection of 0,1 degree.
3. Parallel misalignment is also checked using a dial indicator gauge. An accuracy reading should be taken as the shaft is rotated. Any parallel misalignment will produce an equivalent angle in floating shaft couplings, or where there is a large distance between shafts. Misalignment of 2 mm parallel per 1 000 mm distance between flanges results in 1 degree angular misalignment.
4. As shown in theses exploded view diagrams, the coupling is assembled completely from supplied parts. It is important to take extra care when fitting the bolts, as forcing them through may damage the thick washer and result in protrusion. Fasten all the nylon insert lock nut nuts to the required torque, as shown in the relevant disc coupling ratings tables. The correct torque will ensure that the coupling operates smoothly. Alternate the projection of bolt heads and nuts for the best possible transmission and balance.
5. To ensure longest possible service life, the coupling should be rechecked for both angular and parallel misalignment, one to two hours after initial start-up. At the same time, it is also necessary to check and re-tighten the bolts to the tightening torque shown in the relevant dimension tables. The nylon insert lock nut nuts can be re-fastened up to 10 times, after which , replacement is recommended. The bolts supplied with the coupling are special machined fitted bolts, with tolerances to ensure the best possible fit. **Note:** Do not replace with standard commercial bolts, as looseness and imbalance may occur. Any damage to the stainless disc element pack requires immediate replacement.

2.5.28. Coupling lubrication

The greases used in gear or grid couplings must have characteristics different from general purpose greases, due to the fact that the couplings are rotating. At higher speeds in particular, the centrifugal forces induced by these higher speeds may cause the grease components to separate, resulting in breakdown and subsequent inability to adequately protect metal to metal contact faces. Grease recommendations are generally based on typical ambient temperature ranges of -30^{O} to 95 °C, (some are available up to 140 °C) and selection should be based on a 6-month relubrication cycle, depending on factors such as loading and temperature but taking into consideration ambient conditions such as dirt, contamination, overload conditions, alignment etc.
For normal duty, National Lubricating Grease Institute recommendation is for NLGI#1 (with EP) grade greases.
At lower speeds, (typically below 300 r/min), a grease complying with NLGI #0 may be used. At very low speeds, the use of oil (with moderate EP capabilities) should be considered. (In such cases, the coupling should be totally sealed for oil use, including sealing of the keyways).

2.5.29. Shaft alignment tools

New technology makes shaft alignment easy and affordable.
For mobile devices, SKFs TKSA 11 app (available free from the app store) offers a fully functional demonstration mode allowing the complete alignment process to be experienced without the need to purchase the TKSA 11.
SKF offers a range of shaft alignment systems. Contact your local SKF representative for more information, and to arrange a demonstration.

2.5.30. Lesson summary

In the “Couplings” lesson we looked at the basic features of rigid couplings, and of universal joints. We learned about the characteristics of six types of flexible coupling, and we looked at the installation procedure for each of these. The lesson finished with a brief discussion on the importance of adequate coupling lubrication.

3. Support

Learning online doesn’t have to mean learning alone.
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