

FACTFILE: GCE TECHNOLOGY & DESIGN

1.47 SHAFTS AND COUPLINGS



Shafts and couplings

Learning outcomes

Students should be able to demonstrate knowledge and understanding of:

- shafts and couplings, to include aligned shafts, flexible couplings, universal joints, ball and socket and constant velocity joints.

Course Content

A drive shaft is the component in a machine, such as a car or vehicle that transmits torque and rotation from, in the case of a car, the engine via the gearbox, to the front or rear wheels. Students need to be able to demonstrate their knowledge and understanding of such shafts and any couplings linking shafts that are involved. The key issue for students to be aware of is the fact that the alignment of the drive shaft on a machine needs to be accurate and within tolerance otherwise there will be a tendency for the shaft to strain and possibly break causing catastrophic failure of the machine. Students need to be aware of how slight misalignment might be catered for and how this may be accommodated within a system.

Shaft Alignment

Many machines have drive shafts that transmit power from the motor of the machine to the driven element of the machine. As has been mentioned, in cars there are drive shafts that run from the engine via the clutch and gearbox to the driving wheels, either to the front wheels or the rear wheels. It is very important in any machinery that has a drive shaft such as a car, or pump or generator or any other equipment, that prior to being run, that the drive shaft is accurately aligned. If this is not done there is a real danger of stresses building up within the shaft itself which at best could result in excessive wear to moving parts of the machine and at worse catastrophic failure of the equipment. Misalignment can also be a cause of excessive vibration which again can lead to the failure of the machine. Any break down of machinery, be it a workshop machine or vehicle can be very costly so it is important that shaft alignment is taken into consideration during the design and development stages of manufacturing and the subsequent maintenance of the machine.

In order to make allowances for the tolerances involved in aligning shafts on machinery, engineers have developed methods of taking into account any slight misalignment.

Flexible couplings

Flexible couplings are designed to join a driver, perhaps an electric motor, to the driven equipment in a machine. They are able to transmit torque from one shaft to another when the driver shaft and the driven shaft are slightly misaligned. They are manufactured from an elastic material that is flexible enough to allow for the slight degree of misalignment that may be present in some machines. Flexible couplings can take into account various degrees of misalignment but the limit of difference is up to approximately 3° . They are also able to take into account some parallel misalignment. The purpose of the flexible coupling is to absorb some of the forces acting on the shaft as a result of the slight misalignment and at the same time maintain the rigidity of the shaft to allow for the rotation of the shaft. In addition to being used to help with misalignment, it should also be noted that flexible couplings are also used as a method of reducing vibration or reducing noise. They can also help to resist sudden shock loads on the shaft which can also be a result of misalignment of driving shafts.



Flexible shaft couplings

Universal Joints

As noted earlier, flexible joints cater for a misalignment of drive shafts up to about 3° . If the misalignment is more than that, then other methods of joining shafts need to be considered. If the drive has to be transmitted through shafts where the angle of misalignment is more than 5° , then a universal joint is used. An example of the application of a universal joint is in the drive shafts of a lorry or a car where the drive is to the rear wheels. One factor that needs to be taken into consideration with cars and lorries with rear wheel drive is roads. The drive shaft must have some “give” to allow for the movement that might be caused by bumps in the road. The universal joints are used in vehicles because of their ability to take bumps in the road in their stride. Bumps in the road can cause extra misalignment of shafts as the vehicle is driven along. This is also very important with off road vehicles. The universal joint is able to cope with rapidly changing angularity of a drive shaft.



Universal joint

Ball and Socket Joints

A ball and socket joint is a joint between two components where one of those components is able to move in almost all directions. A ball and socket joint is basically a spherical bearing positioned at the end of a shaft where the spherical element is enclosed in a casing or socket. This allows the ball to swivel into an infinite number of positions. During the production of the swivel joint lubricants were put into the joint. The joint was then sealed to stop the lubricant from seeping out. Ball and socket joints are found in the steering mechanism linkages of vehicles. The example shown below is a ball and socket joint used in a satellite dish mechanism. It allows the dish to be adjusted and moved into an infinite number of positions.

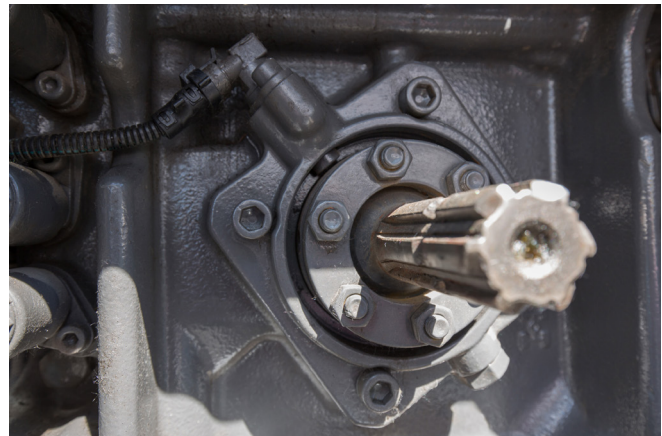
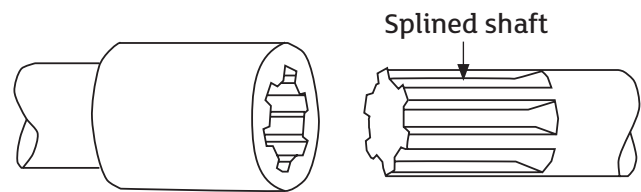


Constant Velocity Joints

The Constant Velocity joint allows power to be transmitted through a drive shaft where the angle of the drive shaft is constantly changing and the rotational speed of the shaft is constantly changing. They are most commonly found on the front wheel drive shafts of cars. There are a number of types of constant velocity joint but all fulfil the requirements of change of alignment and varying rotational speed. Some have a ball bearing race and a series of bearings that allow movement and variable speed.

Sliding Couplings

In a sliding coupling the shaft can move axially while transmitting rotary motion. This is normally achieved by using a splined shaft and slotted coupling as shown below. They are often used in vehicle transmission systems and power tool drives.



? Revision Questions

- 1** Explain why it is important to consider shaft alignment when using a machine or power tool in the industrial workshop.

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- 2** Using notes and sketches show why universal joints are used in the drive shafts of rear drive vehicles.

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- 3** Explain in what circumstances a constant velocity joint would be used.

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