Shear Stress

Helical extension and compression springs are ed to a torsional shear stress and to a traverse shear stress. There is also an additional stress effect due to the curvature of the helix.

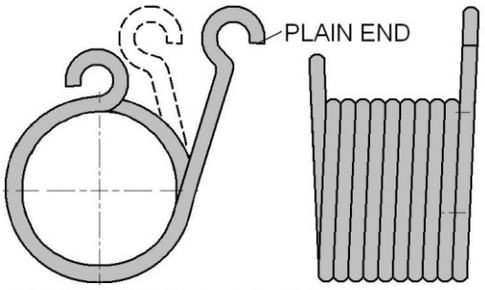
Curvature Effect

The curvature of the wire increases the stress on the inside of a helical extension or compression spring and decreases on the outside.

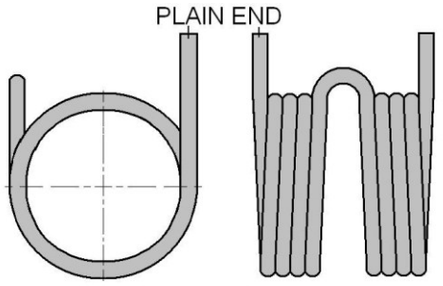
Torsion Springs

Helical torsion springs are used for any application where torque is required, e.g. in door hinges, in automobile starters and so on.

There are in general two types of torsion springs in use, the helical type and the spiral type.



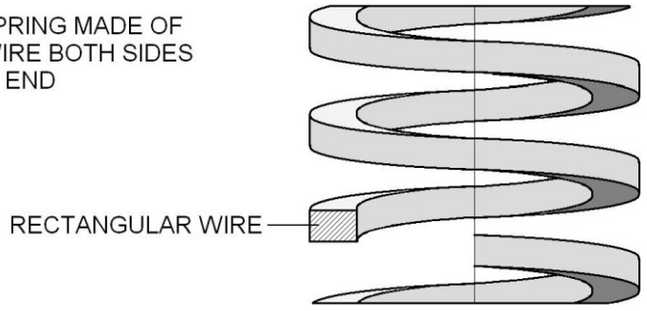
TORSION SPRING WITH SPECIAL ENDS



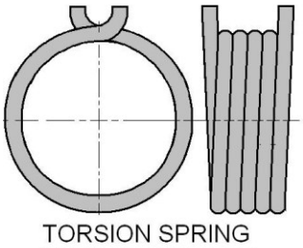
DOUBLE TORSION SPRING

The primary stress in torsion springs is bending. Springs can be made from round as well as from rectangular wire.

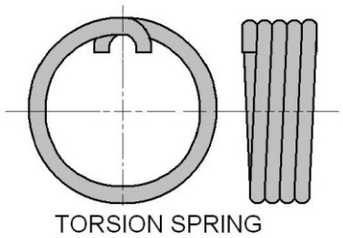
COMPRESSION SPRING MADE OF
RECTANGULAR WIRE BOTH SIDES
WITH GROUNDED END



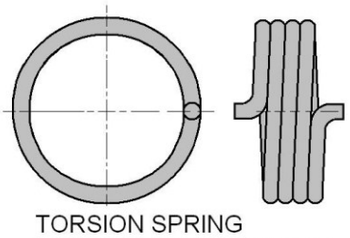
Round wire is often used in non critical applications.



TORSION SPRING
WITH HOOK ENDS

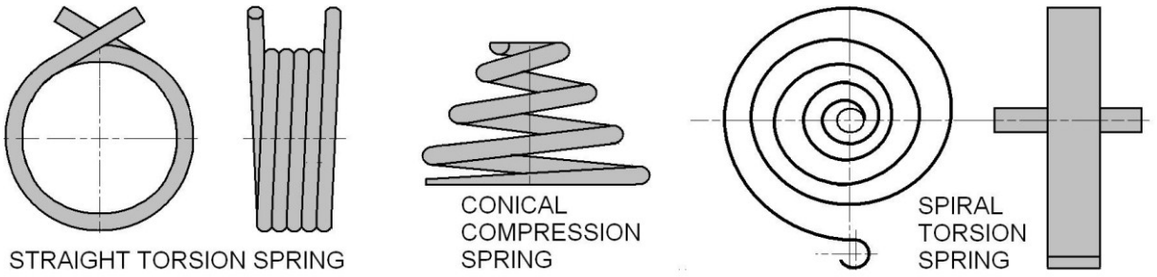


TORSION SPRING
WITH HINGE ENDS



TORSION SPRING
WITH STRAIGHT OFFSET

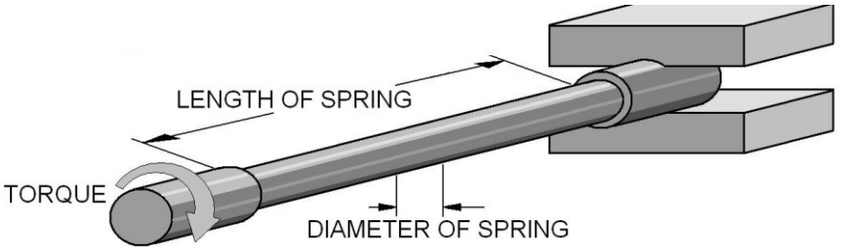
For helical springs the ends can be specified as plain ends and ground ends.



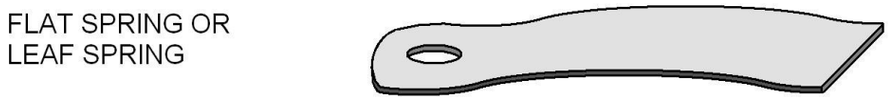
Conical Springs are similar to helical springs, but are cone-shaped. They are able to telescope.

Torsion Bar Springs

Torsion bar springs are mainly used in automotive suspension. They wind up in torsion during use. They need shaped ends to transmit the torsion load to the connecting members.



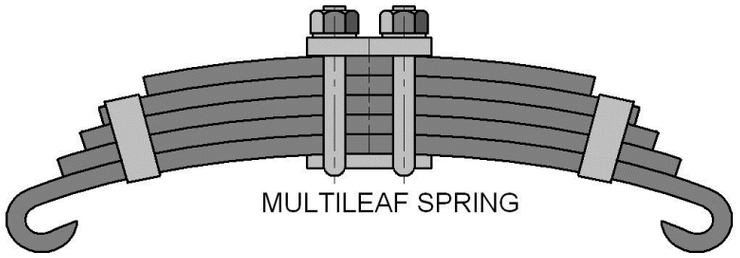
Flat or Leaf Springs



Most flat springs are designed for special devices. Despite the name, these may not be flat at all, but are instead typically formed from flat stock into an appropriate geometry.

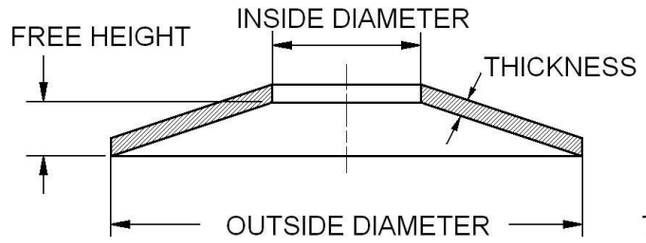
Multileaf Springs

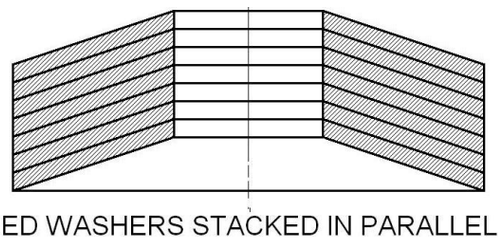
Multileaf Springs are mainly in use for heavy loads as there are trains and tracks.



Bellville Springs

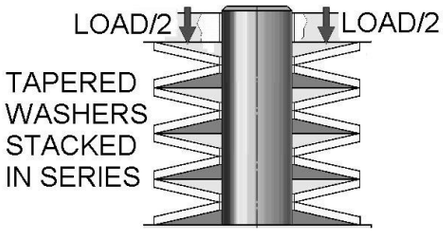
Bellville springs, also called Belleville washers or cupped spring washers are made from tapered washers stacked in series, parallel, or a combination of parallel-series.

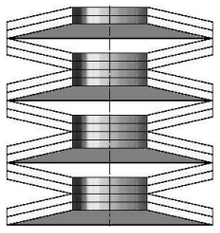




TAPERED WASHERS STACKED IN PARALLEL

They have an unusual load-deflection behaviour that can be used to advantage. Depending on their geometry, Belleville springs can have a range over which the force is nearly constant. They can have an S-shaped curve, meaning that the force can, for short distances, decrease with increasing deflection, or even become negative.





TAPERED
WASHERS
STACKED
IN SERIES
AND PARALLEL

But for many applications Bellville springs are to stiff to be practical. Although they can be stacked, they then become quite large. Their primary use is for generating high forces over short ranges in small spaces.

Load-Deflection Diagram

Every spring has characteristic **load-deflection** behaviour. Its behaviour can be shown in a load-deflection diagram. Understanding this diagram is essential to selecting and designing springs for use in mechanical assemblies.

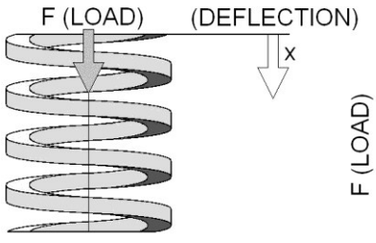
Designing springs can be thought of as selecting the correct load-deflection behaviour along with selecting the correct operating range on the accessory diagram.

The following diagram shows the spring curve of a helical compression spring. It is a straight line, meaning it follows Hooke's law. Hooke's law states:

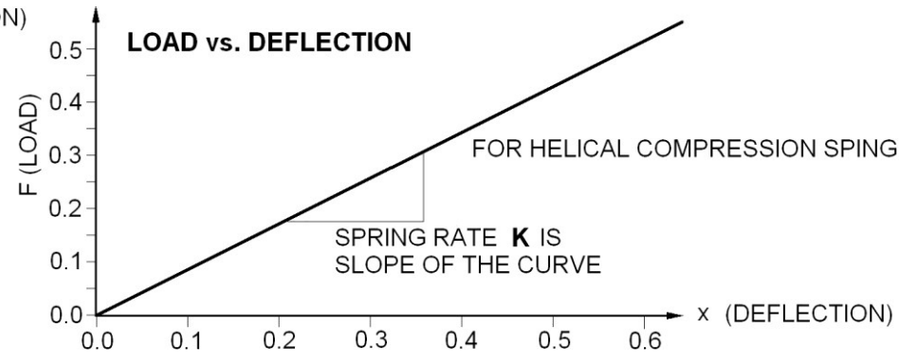
$$F = -\mathbf{K}x$$

WHERE F = SPRING FORCE
x = DEFLECTION
K = SPRING CONSTANT

Helical compression, **extension**, and **torsional springs** generally follow this law, meaning that the spring constant K is indeed constant.



LOAD-DEFLECTION
DIAGRAM FOR HELICAL
COMPRESSION SPRING



There are usually slight deviations from Hook's law at the beginning of deflection and as the spring approaches the maximum allowable material stress. For most applications these nonlinearities are of no consequence.

Springs should be chosen by their desired operating points in mind. The operating points and operating range should be selected to avoid the extreme ends of a spring's deflection.

A **composite** is the made up of distinct parts or elements.

A **block of rubber** can bump or absorb shocks.

Stainless steel e.g. is **corrosion-resisting** steel.

Nonferrous metals are all metals except iron. See therefore chapter "Nonferrous Metals".

An **alloy** is a mixture of metals. See therefore chapter "Alloy".

Oil-tempered steel is heated steel quenched in oil. See therefore chapter "Heat Treatments".

To **manufacture** is to produce, or to fabricate.

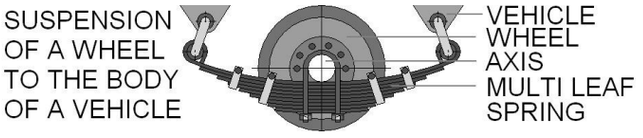
Music wire is mainly used by guitars and other music instruments with wire made of metal.

To **examine** is to test, to look closely, or to inspect.

An **exponent** is a symbol showing what power a quantity is raised to. The abbreviation **kpsi** stands for Kilo Pond Square Inch.

MPa is the abbreviation for Mega Pascal.

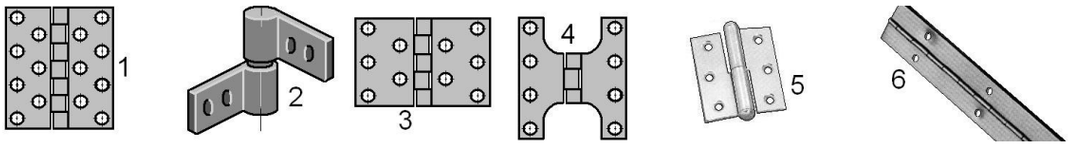
A **suspension** is something that holds up a part. The roadway of a suspension bridge for example is supported with overhead cables. An example of a suspension bridge is the golden gate bridge in San Francisco.



Torsion is twisting. A torsion spring acts by twisting. Practical **applications** of torsion springs are the torsion bars, torsion bar springs, or torque stabilizers in the automotive (car) industry.

To **traverse** is to cross, to pass through. A bridge traverses a river. Cutting a rod causes over its cross section a traverse shear stress.

A **hinge** is the hook or joint on which a door or lid turns. **Hinge** is also called the earth axis.



The shown types are: 1. **Butt hinge**, the most common type for cabinet doors. 2. **Barrel hinge**, which is a sectional barrel secured by a pivot. 3. **Projection hinge**, used where the doors opens up to 180° and clears a projection. 4. **Parliament hinge**, used where the door opens up to 180° and clears projection. 5. **Door hinge** with o pivot. 6. **Continuous hinges**, which run the entire length of the door are also known as "piano hinges" or "strap hinges".

Hinges are types of bearing that connect two solid objects, typically allowing only a limited angle of rotation between them. There are many types of door hinges.

Critical is something if it is relating to a crisis or to a condition in which a chain reaction is self-sustaining.

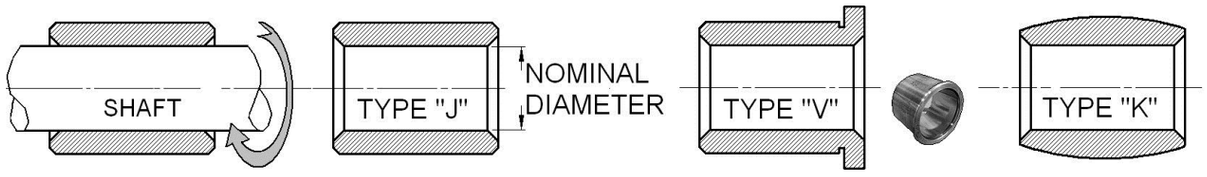
Bearings

A bearing supports or carries a part of a machine as e.g. a revolving shaft and is therefore a connector that permits the connected members to rotate or to move relative to one another.

There are plain bearings used as well as rolling bearings.

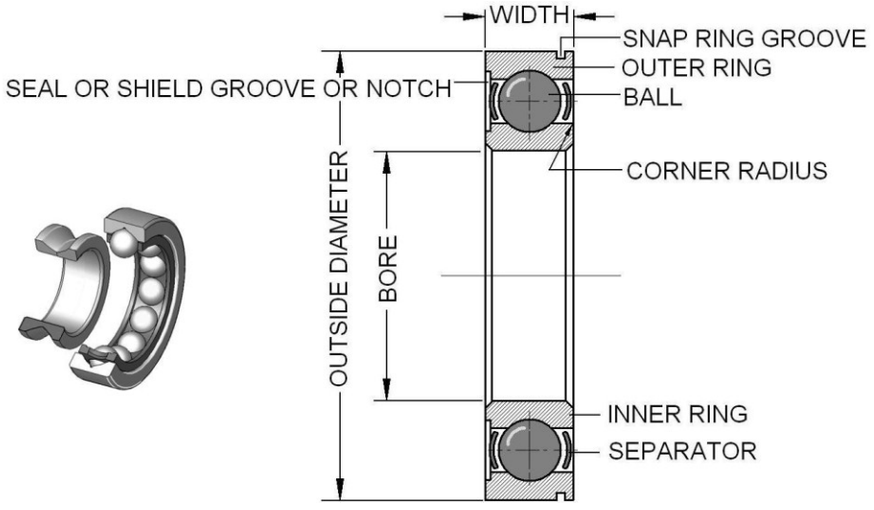
Plain Bearings or Journal Bearings

Plain bearings are bushes made of copper alloy; sinter, thermoset, and thermoplast. The plain bearings below are those made of sinter.



Rolling Bearings

The important parts of a rolling bearing are illustrated in the next figure.



There is the outer ring, the inner ring, the rolling elements and the separator or retainer. The role of the separator is to maintain an equal distance between the rolling elements.

The races are the outer ring or the inner ring of a bearing. The raceway is the path of the rolling elements on either ring of the bearing.

Roller bearings also do have a pitch diameter which is calculated as follows:

Pitch diameter = (outer diameter + inner diameter)/2

Rolling bearings are classified by the following criteria: