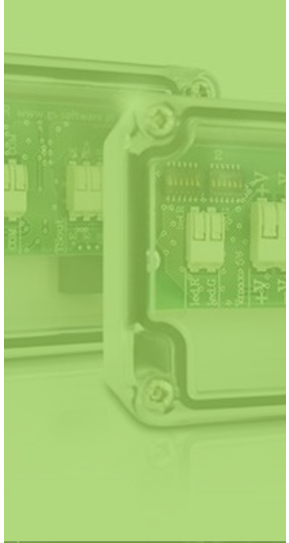
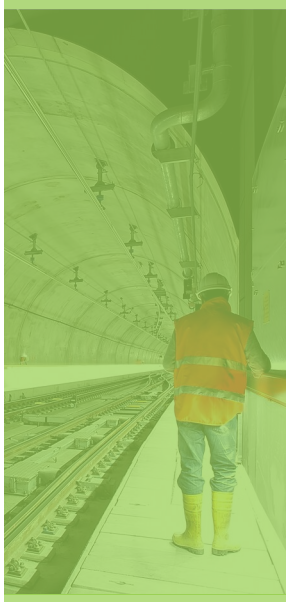




Tacuna Systems

AN OVERVIEW OF LOAD CELLS

Load cells are precision measuring tools used across several industries. They offer a relatively low-cost, durable, and easy-to-install solution to almost any load measurement need. Load cells have been providing quality results in aerospace, agriculture, medicine, industrial weighing, and many other technical fields for decades. As technology continuously improves, load cells are used in increasingly complex measurement applications.

WHAT IS A LOAD CELL?

A load cell is a transducer, or sensor, that converts one type of energy to another. Specifically, load cells convert the kinetic energy of a force into a quantifiable electrical signal. The strength of the signal is proportional to the force (compression, tension, pressure, etc.) applied to the load cell. The electrical signal becomes useful data that can be displayed, stored, or used to control complex systems.

THE PURPOSE OF LOAD CELLS

Load cells are used to convert loads or forces to a calculated electrical signal. This is most commonly used in industrial weighing and load bearing measurements. Load cells are used to test, monitor, and run industrial machinery, medical devices, aircraft loads, and many other applications.

The main types of load cells are hydraulic, pneumatic, and strain gauge. While hydraulic and pneumatic load cells have several advantages, strain gauge load cells are the most commonly used.

HYDRAULIC LOAD CELLS

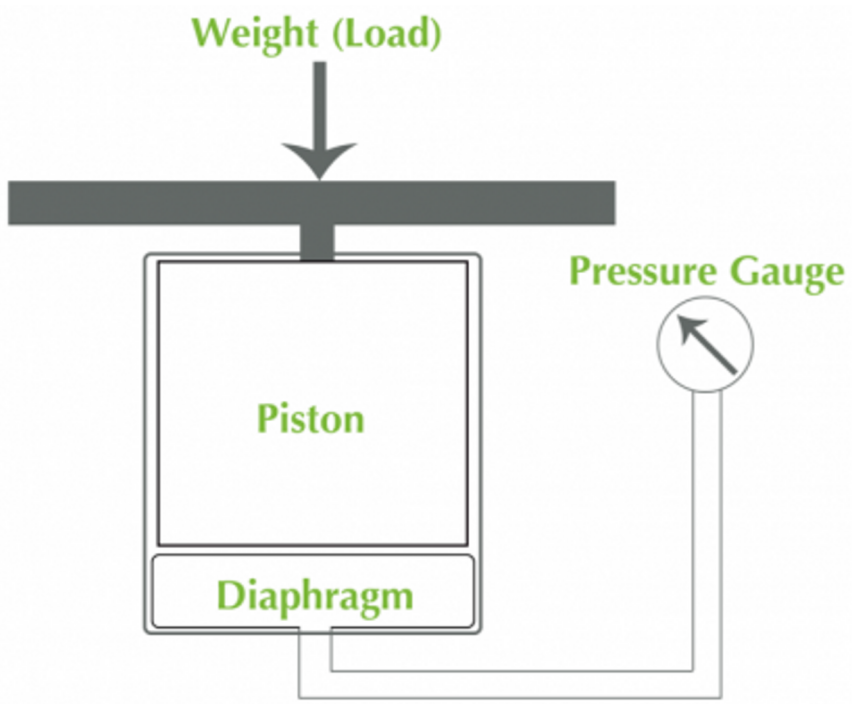
Hydraulic load cells are mechanized by a piston. The measured load is applied to the piston, which pressurizes a liquid filled diaphragm. The change in liquid pressurization is directly proportional to the force applied by the load. The liquid pressure is often measured by a bourdon tube pressure gauge.

BENEFITS OF HYDRAULIC LOAD CELLS

Because the hydraulic load cell design contains no electrical component, this type of load cell can be safely chosen for environments where explosion safety is a concern as there is no ignition capability within the load cell. An additional benefit driven by the lack of an electrical component is that no outside power source is required.

Hydraulic load cells are manufactured with the following components:

- Elastic, liquid filled diaphragm
- A piston with a load platform to properly pressurize the diaphragm
- Pressure gauge, or gauges
- Steel housing for the assembly



Hydraulic Load Cell Diagram

PNEUMATIC LOAD CELLS

Pneumatic load cells function similarly to their hydraulic counterparts, in that fluid pressure is the driving mechanism in the load measurement. The pneumatic load cell design utilizes gas, oftentimes air, as the pressurized fluid.

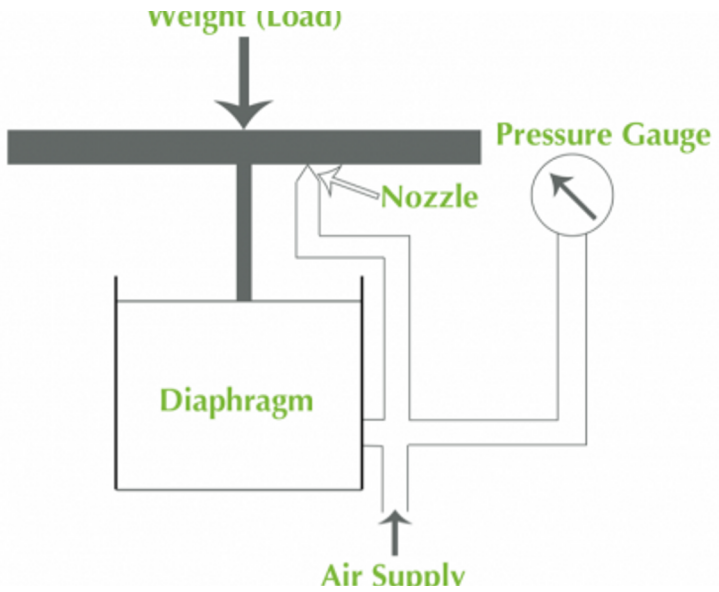
The measured force is applied to one side of a diaphragm, and pressurized air is applied to the opposite side to balance out the force. The pressure of the gas flowing through the nozzle, required to balance out the load on the diaphragm, is measured. It is directly proportional to the force applied.

BENEFITS OF PNEUMATIC LOAD CELLS

Like their hydraulic counterparts, pneumatic load cells are explosion resistant and are generally used in applications with intrinsic safety concerns. The pneumatic load cell is also tolerant of temperature changes with low reactivity to such variables.

Pneumatic load cells are manufactured with the following components:

- Elastic, gas (oftentimes air) filled diaphragm with a supportive platform that the force is applied to
- Air supply regulator
- Nozzle
- Pressure gauge
- Steel housing for the assembly



Pneumatic Load Cell Diagram

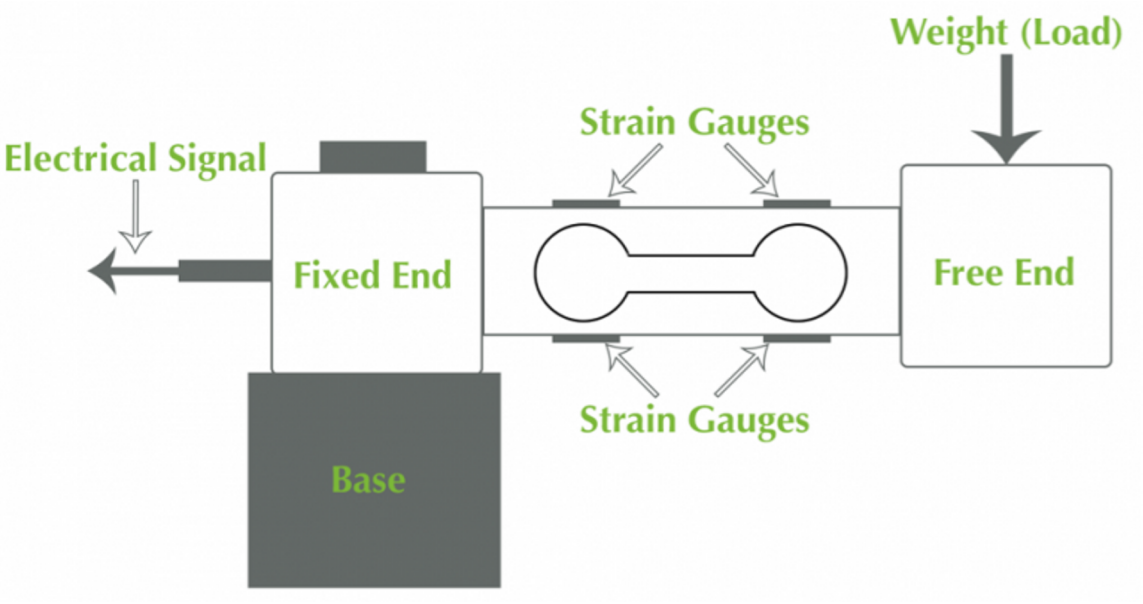
STRAIN GAUGE LOAD CELLS

Strain gauge load cells are the most common. Unlike hydraulic and pneumatic designs, which are driven by pressure differential measurements, the strain gauge load cell is fundamentally driven by changes in electrical resistance.

Any deflection of the strain gauges mounted to the load cell increases the overall electrical resistance across the gauges. Under compression, the wires become shortened and thicker, such that there is less resistance than its balanced control. Under tension, the wires become longer and thinner, increasing the resistance from its baseline state.

This measured difference in resistance creates an electrical signal directly proportional to the force applied by the load. This signal is generally very small, on the order of millivolts, and must be amplified for proper readings. Oftentimes, a strain gauge load cell's design uses a Wheatstone bridge configuration, but can be customized for specific applications.

Strain gauge load cells are often used on cantilever beams, where four strain gauges are directly applied to the measured object. When a load is applied to the free end, the two co-planar gauges will be loaded in tension, while the other two are loaded in compression. The deflection of the beam changes the resistance of the system. The delta is converted to useful output signals.

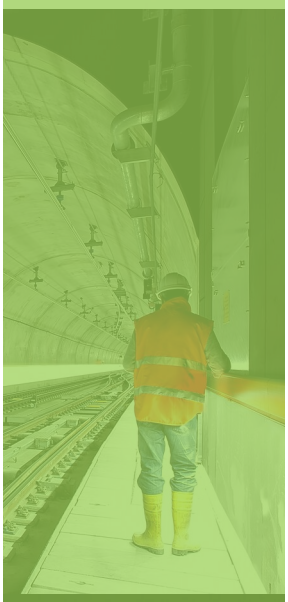


Strain Gauge Load Cell Diagram

Strain gauge load cells do require an excitation voltage to operate. The excitation voltage is the input voltage that the output voltage is measured against. Recall the output voltage changes due to a change in resistance caused by deflection. A balanced strain gauge load cell reads no delta in resistance across the Wheatstone bridge, and the input excitation voltage is equivalent to the output voltage.

BENEFITS OF STRAIN GAUGE LOAD CELLS

Strain gauge load cells are the most popular due to their high accuracy, low price point, and general ease of use. They offer a range of sizes, capacities, and loading types, to fit almost any application. Both current and customized designs can be applied to solve almost any measurement need.



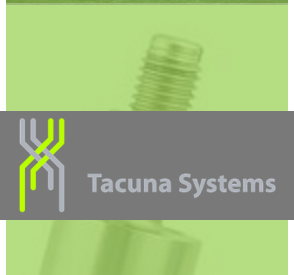
TYPES OF STRAIN GAUGE LOAD CELLS

BONDED STRAIN GAUGES

The most common strain gauges are ones with sensors bonded to the structural body or frame. They are secured to the object whose strain due to subjected forces is to be measured. These sensors of thin wires that, when stressed by a mechanical force, undergo strain. As described in the previous section, the strain causes a change to the wire section area, and therefore a change in the overall resistance of the wire. A Wheatstone bridge circuit is the primary device used to detect this change in resistance of the conduction device. As with most strain gauges, their outputs typically need some form of amplification to be useful.

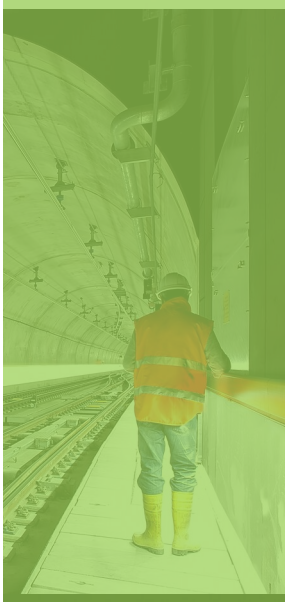
UNBONDED STRAIN GAUGES

Unbonded strain gauges have suspended wires maintained within a diaphragm or piston, and react to pressure changes. They contain two pairs of wires in tension, that when loaded asymmetrically, output a signal proportional to the difference. In both bonded and unbonded strain gauges, there is natural temperature compensation due to the opposing sides of a bridge responding equally to thermal changes.



PIEZOELECTRIC TRANSDUCERS

Like strain gauge censors, piezoelectric sensors can be used for mechanical input transducers. They can also measure force, pressure, and displacement. Piezoelectric materials create an open circuit by separating electrical charges internal to the material when subjected to a mechanical force. Metallic electrodes bonded to the surface of the material form a net charge that can be measured. The piezoelectric effect is a natural property of materials such as quartz crystal and other ceramics.



SINGLE-ENDED SHEAR BEAMS

Single-ended shear beams create a cantilever beam, with one end of the device mounted statically and the other end free to deform under the applied load. A strain gauge is mounted in a small cavity on thin sections of metal. These are useful in tight spaces when the load is applied perpendicularly to the beam. The Tacuna Systems product line includes these examples.

DOUBLE-ENDED SHEAR BEAMS

Double-ended shear beams behave the same as single ended, but instead, have both ends fixed. They are typically used for larger loads, because two fixed ends offer significantly more structural support. For examples, see the Tacuna Systems product offering.

S-BEAM LOAD CELLS

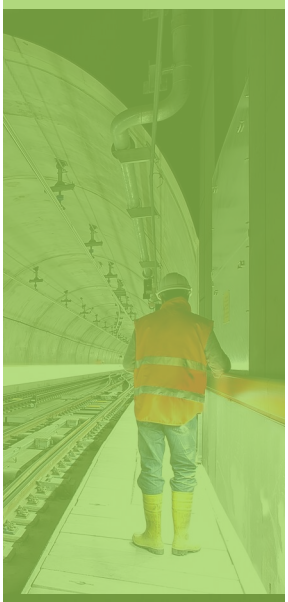
Unlike single and double-ended shear beams, S-beams are optimal for measuring loads in tension or compression. They are typically used in lighter performance testing of springs, hanging scales, and hinges. For examples, follow the link to Tacuna Systems product offering.

PLATFORM AND SINGLE-POINT

Single-point load cells use the same principles as shear beams, but are typically used in stand-alone configurations. They are extremely precise, and optimal for load applications to a single point. For examples, follow the link.

CANISTER AND DISK

Canister and disk load cells are used for compression loading. They have a “button” where the load is applied. Because they are designed to withstand heavier loads than the other load cells, they require more space when installed. They also withstand bending loads better than other load cells. This link shows examples in the Tacuna Systems product offering.



PLANAR BEAM LOAD CELLS

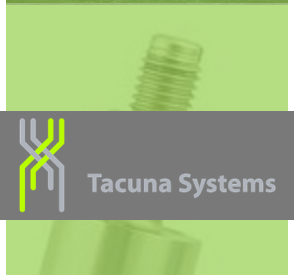
These thin load cells are used in confined spaces. Their low profile makes them useful for precise measurements in medical, postal, and grocery scales. Examples of planar beam load cells can be found here.

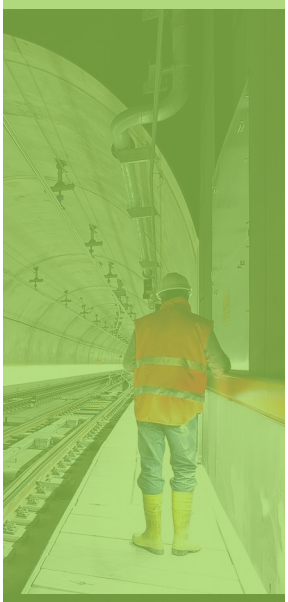
TENSION LINK

Tension Link load cells are used to measure loads aligned in tension. They are used in several suspension applications such as cables, cranes, and hoists. See examples here.

LOAD PIN

Load pin load cells measure shear forces applied to any mechanical pin. They are often used in pulley wheels or shackles. View our range of load pin load cells.





CONCLUSION

Load cells are extremely accurate measuring devices that can be used in a variety of applications. They offer simple and consistent measurements in complex systems. Regardless of your application, Tacuna Systems offers the right load cell. Ask about what innovative solutions we can provide today.

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