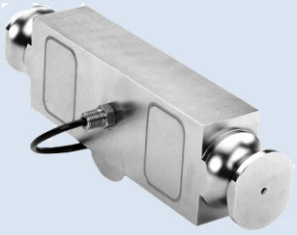
Design and Performance Considerations
Rocker Column vs. Double End Shear Beam Load Cells

Fairbanks rocker column load cell

Typical compression-type load cell



Double-end shear beam load cell

Introduction

Questions frequently arise concerning the differences between rocker column and double end shear beam load cells with respect to design, performance and utility. This document is intended to address those questions.

Materials

Rocker Column Load Cells

All rocker columns, and certainly the Fairbanks rocker column line, employ stainless steel as the sensing element. Some rocker column load cells employ cylindrical cans as the main sealing means. Others use metallic bellows as the sealing element. The Fairbanks rocker column design uses 316 stainless steel in its bellows, electrochemically polished to bring more chromium to the surface to further enhance the excellent corrosion resistance of this alloy. It is believed that the rocker column load cell used by Fairbanks is the only rocker column load cell with this additional manufacturing precaution.

Rocker column load cells are a superior product and should not be confused with Multi-Column Compression Load Cells. The differences of these products will be compared in future publications.

Double End Shear Beam

Double End Shear Beams employ both alloy steel and/or stainless steel in their sensing element bodies. Sealing is typically performed by means of gluing discs or cups over the sensing elements with RTV or similar epoxy like glue. None of these employ 316 stainless steel coverings over the sensing elements.

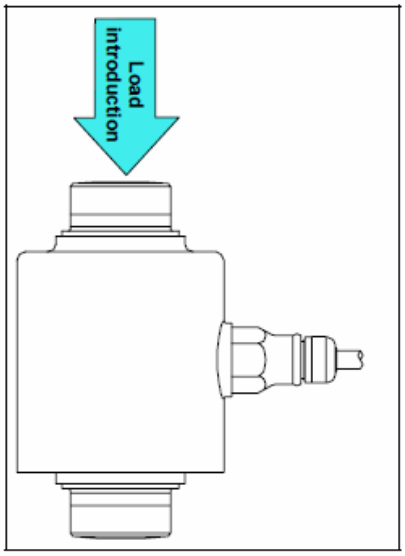
Load Introduction

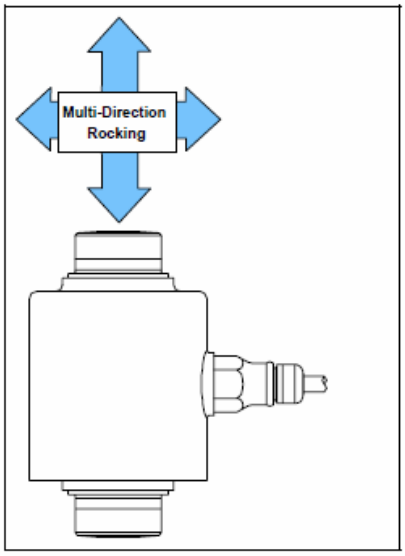
Rocker Column Load Cells

The manner by which load is introduced to the load cell structure is equally as important to performance as the design of the load cell itself. Rocker column load cells provide convex spherical upper and lower loading surfaces for load introduction, adequately spaced from the strain gages to avoid reflected stresses from the high contact stress areas affecting the stress measurement at the strain gage location. Some rocker column load cell manufacturers employ relatively small spherical radii on the loading surfaces to avoid excessive travel across the loading surfaces as the column rocks during articulation and differential expansion of the scale structure. This has the disadvantage of increasing contact stresses to the point where flattening and cracking of the loading surface has occurred.

The Fairbanks rocker column load cell employs a unique dual radius loading surface, with a large radius in the center where the load measurement is made and with a smaller radius at the outer extremities where the rocking occurs. This design provides the best of both worlds where load introduction is concerned.

Since the rocker column load cell is allowed to rock, serious adverse loads due to differential expansion of weigh bridges are avoided and performance in the actual application is enhanced. Similarly, errors caused by weighbridge deflection and shortening are also minimized.





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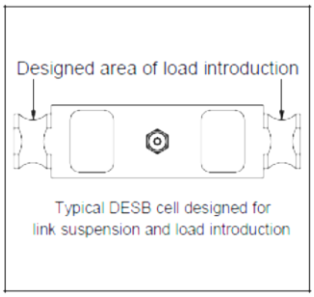
* Hysteresis:
Webster's Seventh New Collegiate Dictionary tells us:
Hys-ter-e-sis: n [NL, fr. Gk hysteresis shortcoming, fr. hysterein to be late, fall short, fr. hysteros later] a retardation of the effect when the forces acting upon a body are changed (as if from viscosity or internal friction); esp: a lagging in the values of resulting magnetization in a magnetic material (as iron) due to a changing magnetizing force.
-hys-ter-et-ic adj

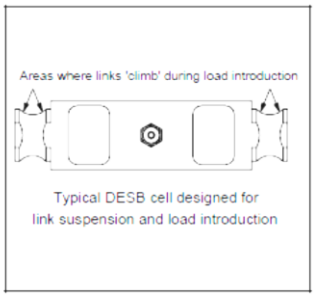
Hysteresis represents the history dependence of physical systems.
If you push on something, it will yield. When you release, does it spring back completely? If it doesn't, it is exhibiting hysteresis, in a broad sense. Hysteresis happens in lots of items. If you place a large force on your fork while cutting a tough piece of meat, it doesn't always return to its original shape. The shape of the fork depends on its history. Many things—forks, for example—after being bent back and forth many times, will actually become stiffer ("work hardening") and then break.

The Fairbanks rocker column load cell is electrically compensated to provide accurate load measurement when the load cell has rocked to a non-vertical position. Other manufacturers provide the "offset" load compensation by grinding the sensing element. Other manufacturers totally ignore the "offset" load error. Loss of scale accuracy is the result and the end user suffers the consequences. Neither of these other methods meet Fairbanks product Quality standards.

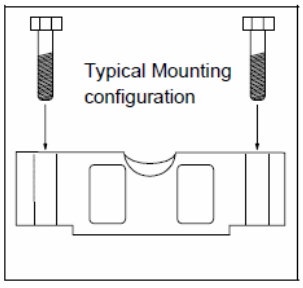
Double End Shear Beam

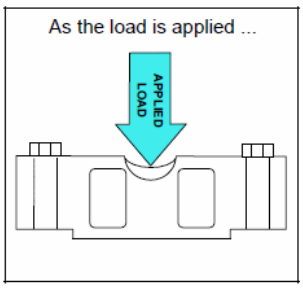
1. There are a number of load introduction principles employed in DESBs. Some are supported at the center by means of a convex pillar and the load is introduced by links at each end. The links are generally forged and they do not have a very good surface for reliable load introduction. The spacing between the link-load cell contact point and the strain gage locations is very short. Serious reflected stress problems results during articulation and differential expansion of the weighbridge. The links will attempt to 'climb' the ears of the cell as the links are loaded and move. This 'climbing' effect will result in inaccurate weights.

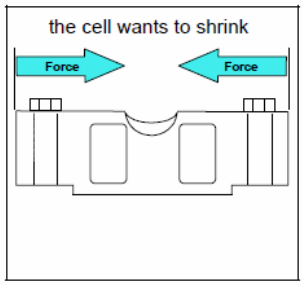




2. In another form the load cell is bolted at the ends and the load is introduced in the center by means of a link. This embodiment suffers greatly because the load cells natural physical tendency to shorten during loading is prevented by the mounting bolts. This causes serious hysteresis* errors. This affects the accuracy and performance of the scale and the end user suffers from the results of an inaccurate scale. * Defined in sidebar.





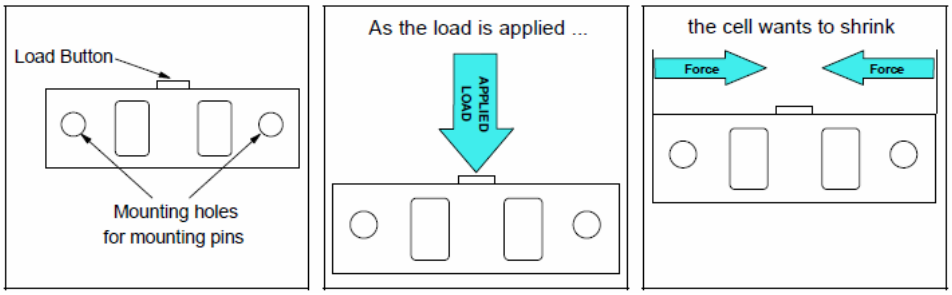


Definition of "hermetic" and "hermetically" –

her•met•ic – Pronunciation Key (hr-mtk) also her•met•i•cal (--kl) adjective - Completely sealed, especially against the escape or entry of air. Impervious to outside interference or influence: the hermetic confines of an isolated life. her•meti•cal•ly – adverb [Source: The American Heritage® Dictionary of the English Language, Fourth Edition]

Hermetically \Her*met"ic*al*ly\, adverb –
1) In an hermetical manner; chemically. – Boyle.
2) By fusion, so as to form an airtight closure. Note: A vessel or tube is hermetically sealed when it is closed completely against the passage of air or other fluid by fusing the extremity; sometimes less properly applied to any airtight closure. [Source: Webster's Revised Unabridged Dictionary]

3. Another form is mounted at the ends by means of horizontal rods or pins. This design has similar problems as listed above in #2. In this case, the load cell's natural physical tendency to shorten during loading is prevented is prevented by the horizontal pins. This also causes serious hysteresis errors (hysteresis is defined in sidebar at left). This affects the accuracy and performance of the scale and the end user suffers from these results.



Hermetic Sealing

Some have said that a load cell is a load cell. We know that is just not true. All load cells are not created equal. Fairbanks only uses stainless steel truly hermetically sealed load cells. Some load cells are 'potted', some are hermetically sealed only where the strain gages are located and some load cells are totally hermetically sealed, hermetically sealed at the strain gage location and hermetically sealed at the cable entry.

So what does "hermetically sealed" really mean?

You may have noticed in Webster's definition (see sidebar on left) it has been pointed out that the term has been, and continues to be, misapplied. A simple potted seal is not the same as hermetically sealed. Fairbanks truly hermetically sealed load cells feature welded enclosures and gauge chambers filled with nitrogen gas. This method produces the absolute best load cell available today.

Design and Performance Considerations
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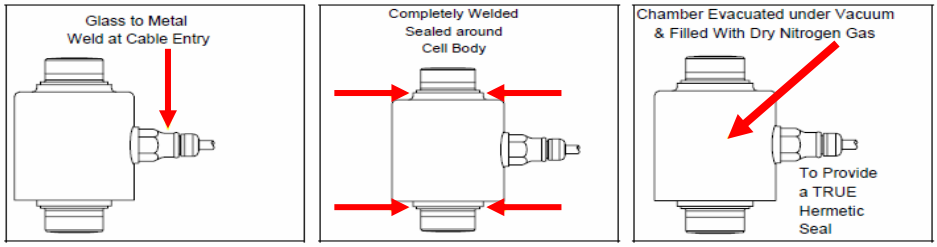
Rocker Column Load Cells

The Fairbanks rocker column load cell is hermetically sealed at the enclosure and at the cable entry, the latter by means of a glass to metal sealing element.

Most rocker column load cells are hermetically sealed at their main sealing element, but not all manufacturers hermetically seal at the cable entry. A load cell is no better than its weakest seal. Rocker column load cells which are not hermetically sealed at the cable entry are not true hermetically sealed load cells and should not be considered as such.



Double End Shear Beams

Most DESB are potted by design and will simply not hold up well in truck scale environments. That has been proven time and time again, in spite of what some will argue.

Some DESBs are hermetically sealed at the strain gage location but not at the cable entry. They are therefore not much—if any—better than the potted versions.

Design and Performance Considerations
Rocker Column vs. Double End Shear Beam Load Cells

Performance

Performance is related to both design and load introduction. The latter has already been addressed. Only design related performance will be discussed here.

Rocker Column Load Cells

All load cells employ semiconductor strain gages to linearize the column except those which employ A-D converters. There are no particular advantages, one over the other.

Hysteresis performance is a function of material choice, strain gage selection and heat treating. Fairbanks employs well controlled stainless steel alloys, uses a very comprehensive heat treating process and employs negative hysteresis strain gages to minimize any residual positive hysteresis in the heat treated alloy. Other rocker column load cell manufacturers do not employ negative hysteresis strain gages.

Creep is a function of material choice, heat treating and strain gage design. Since Fairbanks rocker column cells and strain gages are manufactured together, by the same people, creep is optimized. 100 percent of Fairbanks load cells are creep tested. We do not use sample testing. Other manufacturers do random sample testing of creep.

Temperature compensation of zero and span are time consuming operations. Fairbanks' temperature compensation techniques are not conventional and provide important proprietary manufacturing advantages.

Fairbanks provides mV/V/ohm and mV/V calibration. No other manufacturer provides such calibration. The importance of this is twofold. Load cells can be replaced without the need for readjusting the corners or sections. Load cells can be replaced without the need for system recalibration. The technical bases for these features are a bit too involved to be included here, but will be covered in future publications.

Double End Shear Beam Load Cells

DESB load cells are inherently linear and therefore semiconductor strain gage linearization is not required. This doesn't represent any particular performance advantage. However: It is not believed that negative hysteresis strain gages are being employed in DESBs since they suffer from load introduction-induced hysteresis errors which do not lend themselves to such compensation.

Design and Performance Considerations
Rocker Column vs. Double End Shear Beam Load Cells

Other than the Fairbanks rocker column no other manufacturer is employing mV/V/ohm and mV/V calibration in the manufacturer of load cells. Hence, field replacements are potentially more time consuming.

Installation

Rocker Column Load Cells

For appropriate application only simple upper and lower loading cups are required. Simple alignment fixtures are used for installing the load cells in a vertical position.

Double End Shear Beam Load Cells

Large and relatively expensive castings are usually required for the DESB.

Cut-away view of hermetically sealed rocker column load cell

Summary

The totally hermetically sealed rocker column load cell offers major performance advances over Double End Shear Beam load cells. DESB load cells are not totally hermetically sealed, suffer from serious load introduction problems and are more difficult and expensive to apply.

For more information about the many Fairbanks Scales products, please visit www.fairbanks.com.