WEIGHBRIDGE LOAD CELLS

WEIGHTRON BILANCIAI
INDUSTRIAL WEIGHING SPECIALISTS
BILANCIAI GROUP

Don’t judge a load cell by its cover – appearances can be deceptive!

Introduction

Strain gauge load cells are the life blood of modern, high performance industrial weighing systems, playing a particularly important role in weighbridge systems. Despite the harsh operational environments weighbridges encounter (extreme temperatures, ice, snow, wash-down, flooding, excessive braking and minimum maintenance), the load cells are expected to provide exceptional reliability and accuracy.

When Arthur Lincoln Thurston patented the first compact compression strain gauge load cell in 1949, little did he know that this humble invention would continue to be at the heart of industrial weighing over 70 years later. Modern units have come a long way since then, but the basic technology and over-riding sound mechanical design-build principles established by Thurston are still vitally important.

One fact is clear. There are no quick and easy ways to produce high quality weighbridge load cells. Unfortunately there are always companies who will try to make a product cheaper by cutting corners - even though quality will suffer. Short circuiting any of the fundamental principles or processes will result in inferior quality load cells. As a result, low cost weighbridge load cells are unlikely to meet all performance criteria and will almost certainly turn out to have a higher cost of ownership in the long term.

Unfortunately low cost - low quality load cells have entered the market from unscrupulous manufacturers and some weighbridge companies are happy to try to capitalise on this. At first glance these inferior load cells may look the same as their high quality counterparts from the outside, but there the similarity ends. Often the problem stems from the fact that some load cell manufacturers produce a ‘golden load cell’ for weights and measures evaluation, which is not typical of the quality of normal production run load cells. In fact this evaluation load cell may not have been manufactured at the same site as normal production load cells. (VCAP has been established to try to bring greater control to load cell manufacture- see details at the end of this document.)

The losers in all this are the end users, but they are often oblivious to the consequences, believing the ‘false’ performance claims of the weighbridge supplier. More often than not, the user may not be aware that inaccurate weighing is costing them money as well as risking their reputation with their customers.

The following key factors are vital to ensure manufacturers produce high capacity load cells that consistently meet the required performance and reliability criteria:

- Sound mechanical design principles including optimised environmental sealing
- Repeatable, high specification material properties and heat treatment for the critical load cell structural components
- High quality strain gauges designed specifically for the load cell measuring element
- Well disciplined manufacturing and testing procedures
- 100% product testing

Mechanical design

The mechanical design criteria for a load cell are of paramount importance. Testing and compensation procedures can only fine trim performance characteristics so therefore the original design must take into account real working environments. The design should ensure the load cell has good tolerance to off-axis, side and angular loading. Good environmental sealing is vitally important to prevent premature failure especially with regard to cable entry.

Material Specification

Load cells are very low deflection springs that must behave in a highly repeatable manner as they are loaded and unloaded. As a result optimised material selection and heat treatment for the measuring element and other key components play a critical role in this.

Strain Gauges

The matching of strain gauge characteristics to those of the load measuring element is crucial, especially where creep and linearity characteristics are concerned. The performance of the finished load cell is also directly dependent on the repeatable nature of the strain gauge bonding process.

Testing

Load cells have individual characteristics and therefore each and every load cell should be tested and compensated during the manufacturing process. It is often in this area that lower quality manufacturers cut corners to reduce cost. Testing must include load cycling and temperature testing.

Design concept

There are three fundamental load cell designs used in modern weighbridges:

- Single Ended Beam Cells
- Double Ended Beam Cells
- Canister

Single Ended Beams

Cumbersome high capacity single ended bending beam load cells represent out-dated technology and are far from ideal for weighbridges. Typically they only have four strain gauges and are susceptible to torsional, off axis and side loading effects. Mounting assemblies and fasteners are subjected to high forces as load is applied to the cantilever beam. Design performance limitations usually restrict construction to alloy steel rather than stainless steel and ensuring effective environmental sealing can also present a problem.

Double Ended Beams

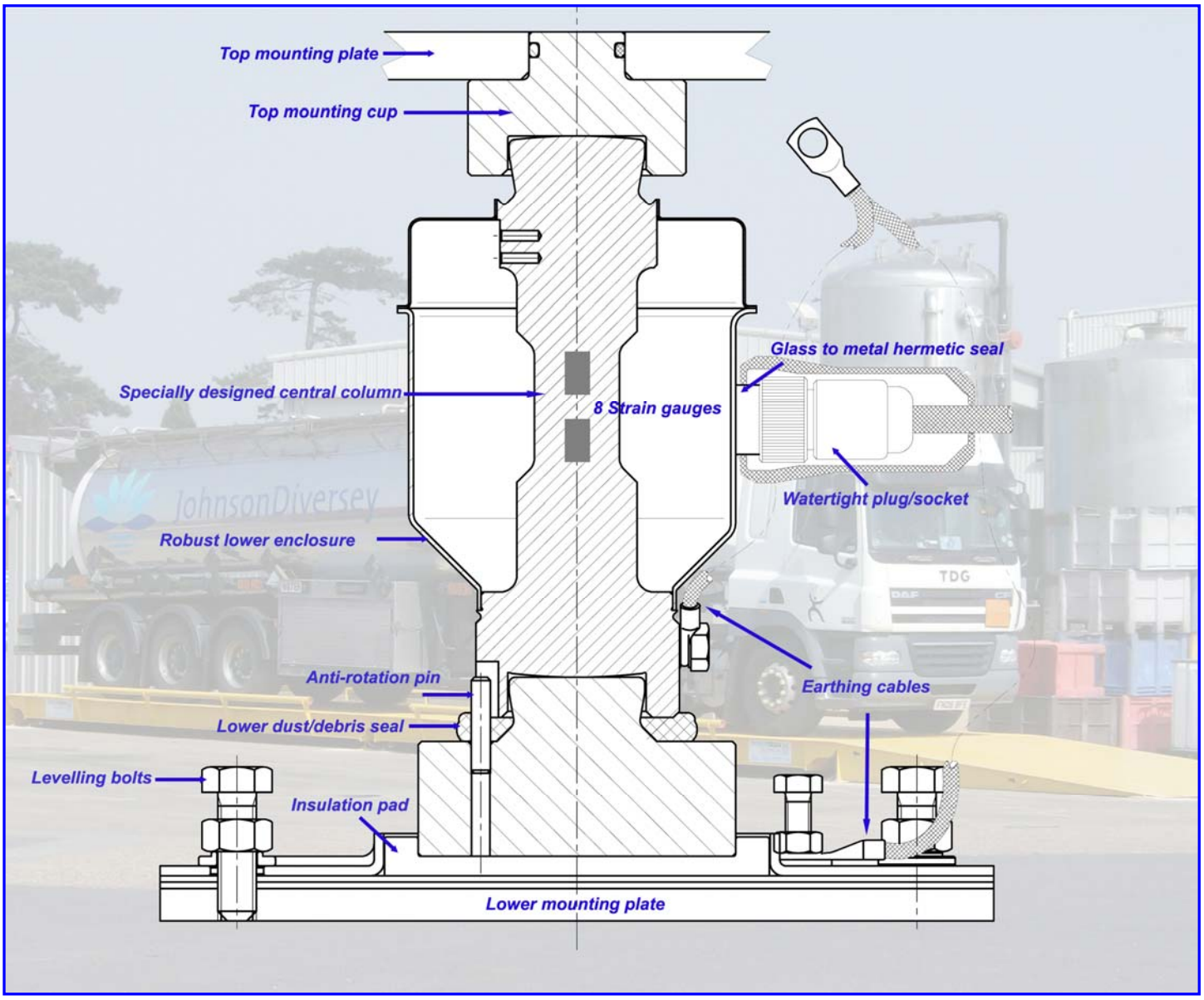
Double ended shear beams provide a better mechanical solution than single ended beams and the shear technology provides a product less susceptible to non-axial forces. However there are a number of questionable and misguided claims relating to their reliability, especially when mounting assemblies incorporate large ball bearings. Contrary to belief, such assemblies do not absorb shock and require high maintenance. In practice this is often not carried out, leading to poor performance and premature mechanical failure, especially in harsh environments.

Canister Load Cells

Canister load cells have a long history in weighbridge applications and are considered to offer the best solution - provided they are well designed and built. The Bilanciai Group have dedicated years of research and field testing in order to develop the ultimate patented canister load cell family.

The analogue CPR and digital CPD models have an unrivalled track record for reliability and performance. Both are based on the same mechanical envelope and key design features set these load cells apart from competitive units (see diagram below). Their engineers have not just focussed on the design of the load cells themselves, but also on the functionality of the mounting assembly. Key features are:

- The central column has a dedicated shape that incorporates top and bottom spherical surfaces
- Proprietary heat treatment provides a robust yet highly repeatable central column
- The design incorporates eight strain gauges, strategically placed to provide optimum performance even under adverse loading conditions
- A compact special seal is incorporated in the bottom assembly to prevent dust/debris/water causing problems. This removes the need for more onerous covers, which can do more harm than good
- The inside of the load cell is protected form the environment via a fully weld sealed two part stainless steel outer housing. The bottom section is noticeably thicker than the top in order to provide mechanical protection to the load cell
- A glass to metal seal ensures IP68 sealing for the cable entry. The digital CPD has an external plug/socket to allow the cable to be removed. Braided rodent proof cable is available.



- The anti-rotation pin prevents the load cell rotating in its mount thereby eliminating possible cable damage

- The insulation pad between the bottom mount assembly and the base plate minimises damage due to electrical discharge. Braided copper cable electrically links the bottom of the mount assembly with the top plate, bypassing the load cell.

Digital Load Cells

Digital load cells were first developed in the 1980s initially to make low cost, low capacity load cells in high volumes. The concept was based on the presumption that emerging low cost electronics could be used to provide output compensation corrections for less than perfect load cell designs.

It is only really over the past decade that their advantages have been fully utilised for high capacity weighbridge load cells, providing important and tangible benefits for both the manufacturer and the end user. The Bilanciai Group have been granted two patents relating to the design and use of digital load cells(US 7,151,230 B2 and US 7,361,851 B2) Each digital load cell has on-board electronics, which carry out a number of functions and supply a digital representation of the load on each load cell. The load cells at the heart of a weighbridge system form a communication network allowing direct access to the parameters of individual load cells. The individual calibration data for each load cell is stored in the electronic memory, facilitating calibration, trouble shooting and replacement.

Effects of ambient temperature changes on weighbridges

In some regions, ambient temperatures can easily change by over 50°C from winter to summer. Steel weighbridge decks act as a huge heat sink and they may reach temperatures approaching 80-90°C. There are two temperature related factors to be considered which can affect performance.

Firstly, the deck will expand and contract in three dimensions. An 18 metre deck will expand lengthways by approximately 0.2 mm per degree C change in temperature, meaning an unrestrained deck could change in length by around 16 - 18 mm. The width will also change by approximately 3-4 mm. Meanwhile the relatively shaded concrete foundations will see a much smaller expansion. Overall the relative expansion could be around 10 – 12 mm. The effect of this longitudinal expansion will be to introduce angular loading to the load cells, which could be in the region of 1.5 degrees. If the load cells are not designed to accommodate this off-axis loading (often referred to as cosine error), weighing errors of several scale divisions can be introduced.

Secondly, temperature changes have an affect on the load cell performance itself. High quality load cells are individually compensated for temperature effects on span and zero during manufacture, usually over the range from -10°C to +40°C. Lower cost load cells may well not have been individually tested and compensated, further adding to unwanted errors.

Foot note: Verified Conformity Assessment Program Procedures

In order to level the playing field with regard to load cell quality, the US authorities have introduced the Verified Conformity Assessment Program, or VCAP. This is a program initiated by the National Conference on Weights and Measures to ensure compliance of certain device types with environmental requirements. These device types are ones for which performance can be affected by changes in their physical environment. The program has started with load cells only. Compliance with the VCAP can be verified by submitting to a VCAP audit of the

suppliers manufacturing/testing facility by a VCAP auditor. The auditor will verify that the previously mentioned quality and control elements exist are documented, and that the appropriate procedures are being followed. The auditor also verifies that the proper equipment needed to test and calibrate the devices (load cells) manufactured is present, sufficient for the task, and that they are being properly calibrated and operated. The audit will also include testing of a randomly selected device. The program is intended to prevent manufacturers from producing the 'golden load cell' for evaluation and then supplying inferior products from uncontrolled sources. The VCAP audit is site specific. If there is more than one site where the testing of the device takes place, then each site must be audited. If the site does not perform any activities that affect the performance of the device and does not perform any device testing, it does not need to be subjected to a VCAP audit. The intent of the VCAP is to provide a level of assurance that these devices perform at a level equal to or better than the device that was evaluated by NTEP.

Certificate of Registration

nqa global assurance

This is to certify that the Quality Management System of:

Societa Cooperativa Bilanciai
Via S. Ferrari n'16
Campogalliano (MO), 41011 Italy

Applicable to:

Manufacture of Load Cells

Has been assessed and approved by

National Quality Assurance, U.S.A., against the provisions of the National Conference on Weights and Measures (NCWM) / National Type Evaluation Program (NTEP)

Verified Conformity Assessment Program (VCAP)

Per NCWM Publication 14, Section S.1.c., as adopted July 16, 2009

For and on behalf
of NQA, USA, Acton, MA 01720

Certificate Number:	13731
EAC Code:	18
First Issued:	April 21, 2011
Valid Until:	April 21, 2014

This approval is subject to the company maintaining its system to the required standard, which will be monitored by NQA, USA.

SOCIETA' COOPERATIVA
BILANCIAI STRUMENTI E TECNOLOGIE PER PESARE

EUROCELL CELLE DI CARICO PER LA PESATURA

Cella di carico - Foglio di calibrazione
(Load Cell - Calibration Sheet) OIML

Tipo: *(Type)*	**CPD-M**	
Portata: *(Capacity)*	**35000**	*Emax (kg)*
Classe: *(Class)*	**C3**	*-10/+40 °C*
Matricola n.: *(Serial N.)*	**11070263**	**(cod. 567420)**
Errore combinato: *(Combined Error)*	**0,0109**	%
Creep in 30 min:	**≤ 0,017**	%
Sensibilità: *(Rated Output)*	**200000**	*punti*
Bilanciamento di zero: *(Zero Balance)*	**≤ 0,50**	*%Emax*
E_{min} :	**0,5**	*%Emax*
E_{lim} :	**150**	*%Emax*
p_{LC} :	**0,8**	
Operatore n.: *(Technical Operator)*	**311**	
Data di collaudo: *(Calibration Date)*	**15/02/2011**	*(DD/MM/YYYY)*
TC:	**UCM 00/002-F**	

567420 43750 11070263

Collegamenti: *(Wiring)* **RS485**

Il responsabile
A. S.

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WEIGHTRON BILANCIAI

INDUSTRIAL WEIGHING SPECIALISTS

BILANCIAI GROUP

Weightron Bilanciai are leading suppliers of **weighbridges, weighbridge peripherals, industrial scales, process weighing systems, load cells, hazardous area weighing systems, crane scales, weighing software, liquid filling machines, radiation detection systems** and **laboratory balances.**

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