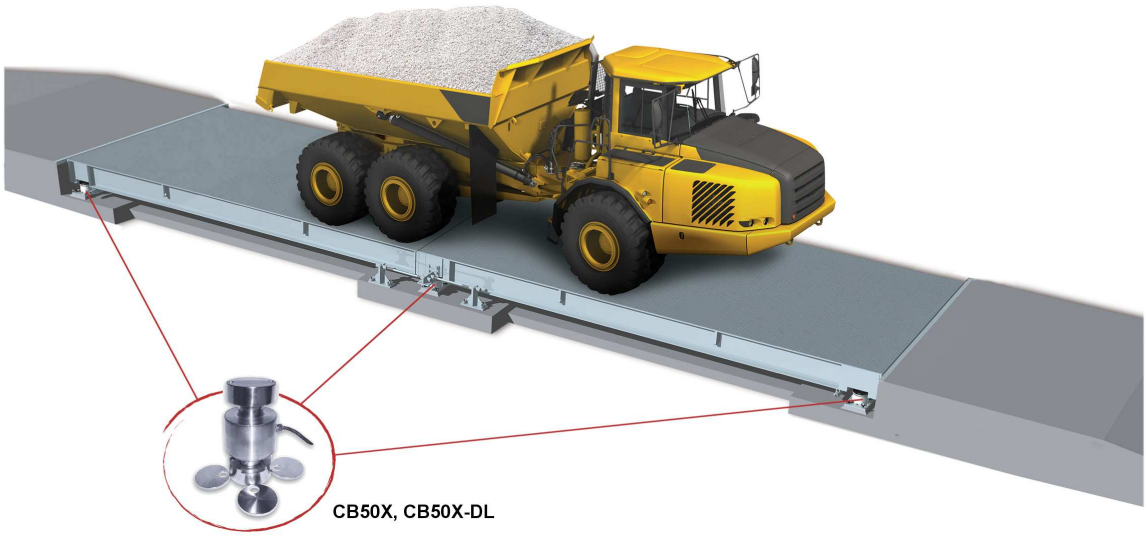
Introduction

Vehicle scales can be considered as a platform that is supported by weight-sensing elements which produce an output proportional to the load placed on the platform. These sensing elements include either analog or digital load cells. Digital load cells are typically analog load cells including in-built signal processing and analog to digital conversion.



In weighbridge application, load cells are a part of a multiple load cells system subject to specific adverse forces. To fully evaluate this system performance, the load cell OIML specifications, allowing to know the individual load cell characteristics, are not sufficient.

- ***In weighbridge application, it is a prime importance to consider the load cells behaviour under real condition of use … this is the scope of this document.***

System configurations

Analog load cells systems

CB50X load cells are connected in parallel via a junction box. Each load cell provides an output of 2 mV/V at nominal capacity. The combined output is the arithmetic mean value of the individual load cell outputs.

The measuring indicator uses an amplifier, an analog to digital converter (ADC), a microprocessor and software to produce a calibrated reading (in weight units) on the display.

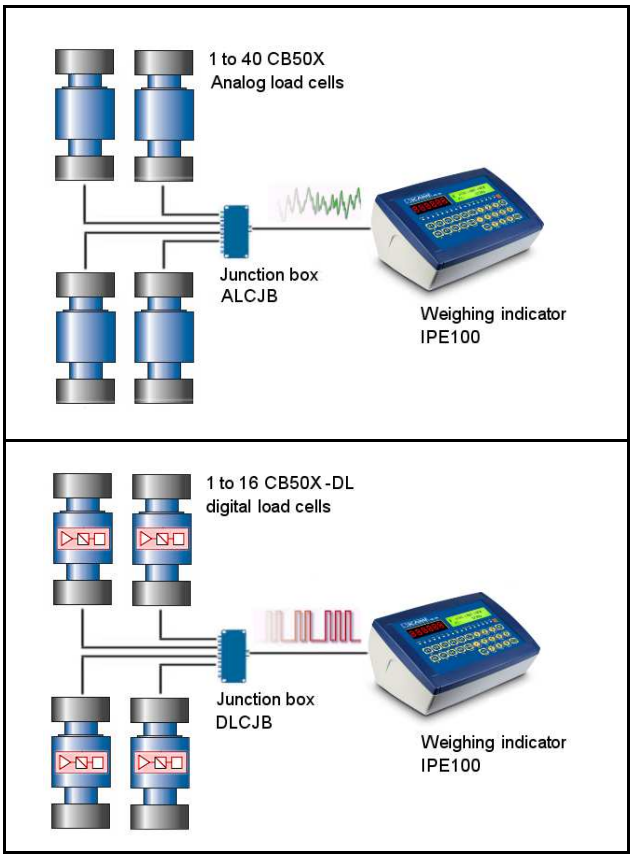
The main disadvantage of this system is the difficulty to detect a load cell failure. Also if a failure is noticed, its cause can often be difficult to identify and requires the use of test loads and additional measuring equipment.

Digital load cells system

A typical digital system consists of a number of digital load cells connected to a measuring indicator.

An important difference between analog and digital load cell systems is the fact that although connected together, each digital load cell operates as a truly stand alone device. This feature offers benefits in terms of system set up, calibration, diagnostics and overall control.

CB50X-DL digital load cells are connected via a RS485 interface on a specific protocol. To offers an advantage in terms of communication speed, the indicator sends out a data request which causes the CB50X-DL to respond in an address sequential order.



CB50X & CB50X-DL, proven performance in weighbridge applications

Principle of measurement

CB50X and CB50X-DL load cell measuring principle is based on column compression measurement. Although conceptually simple, the column element has a number of specific characteristics which makes these load cell difficult to design and produce. The column itself should be long enough, with respect to its cross section, to provide a uniform strain field, unaffected by end conditions. Since the column configuration is subject to effects from off-center load components, provisions must be made to minimize these (see § off-center compensation).

Column load cells are inherently non-linear due to change in cross section, while deforming under load. This non-linearity is compensated with semi-conductor gages for the CB50X and by software for the digital CB50X-DL.

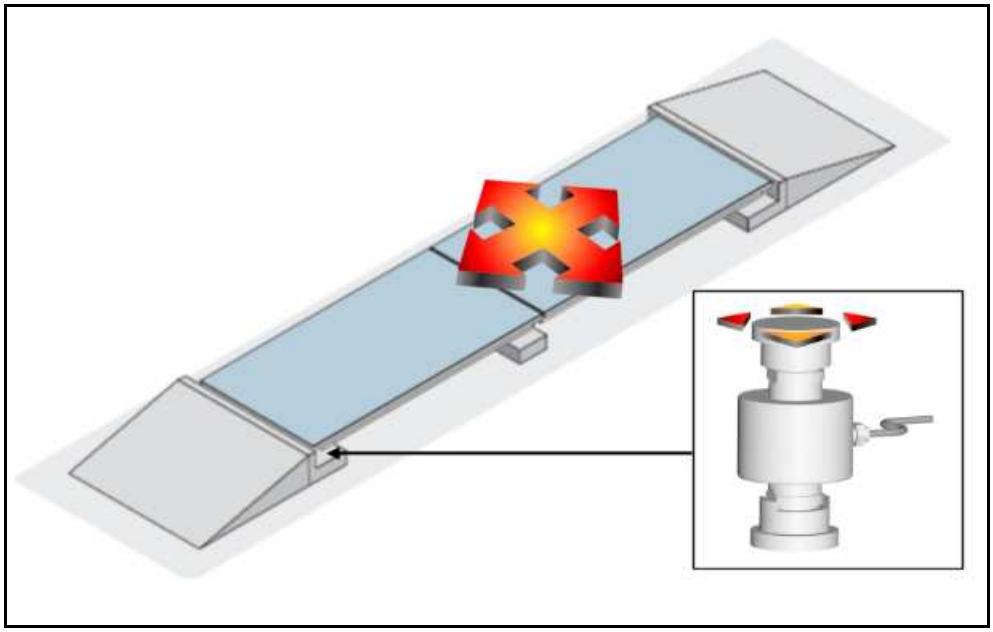
Load introduction

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.

The CB50X is a pendulum load cell designed to automatically restore the mounting construction to a stable initial position in the case of a small lateral displacement of the load introduction. This assembly is ideally suited for weighbridge applications. It allows free motion in any direction in the horizontal plane at the same time supplying a restoring moment whilst retaining the slope of the load sell. It allows for thermal expansion of the bridge structure.

Since the 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.

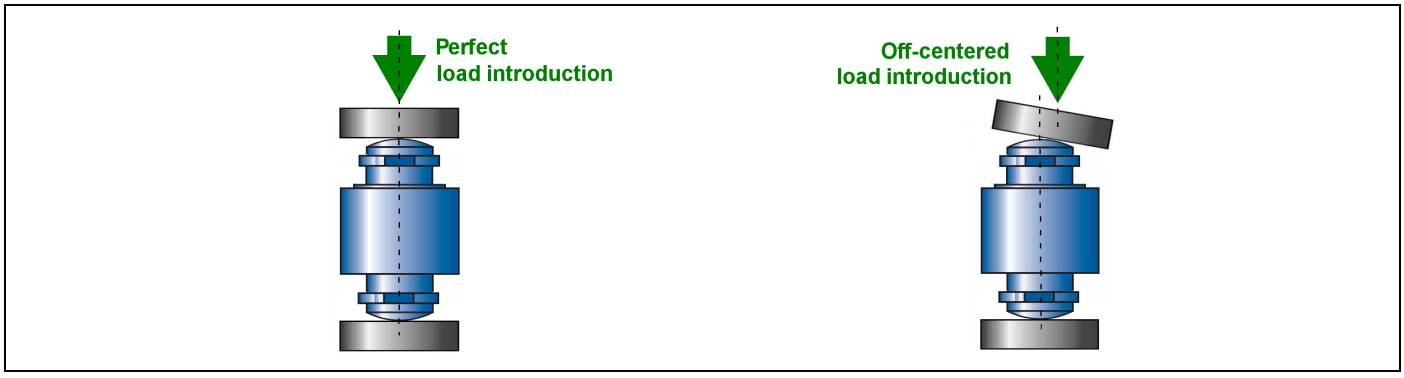
Similarly, errors caused by weighbridge deflection are also minimized.



Off-center compensation

To provide accurate measurement when the load is off-centered, CB50X and CB50X-DL load cells are mechanically compensated by rectifying the sensing element and by ensuring a perfect gage positioning.

Other manufacturers provide electric compensation (FLINTEC), whereas lot of manufacturers totally ignore the “offset” load error. Loss of scale accuracy is the result and the end user suffers the consequences.



Signal output in multiple load cells system

CB50X signal trimming

Traditionally, when connected in parallel, analog load cells are loaded with the output impedance of the other load cells. To be accurate, the output of each load cell is externally trimmed by placing resistances (inside the J-box) to reduce the load cell excitation. This method has some disadvantages :

- the adjustment process must be repeated each time a load cell is exchanged
- The individual load cell adjustments are very time-consuming, particularly for high-capacity systems.

To avoid these disadvantages, the output of each CB50X is adjusted in factory. With this approach, we adjust the short circuit current and output impedance of each load cell to a standard value, within a close tolerance. This ensure that :

- multiple load cell systems will be corner adjusted without further trimming
- system corner adjustment and system calibration is preserved, even when a load cell is replaced.

CB50X-DL rationalized digital output

With digital load cells, each output is independent. The CB50X-DL include a 24 bits analog to digital converter to provide :

- Output of 200 000 counts, accurately pre-calibrated in factory
- measuring rate up to 200 meas/s with digital filters especially designed for weighbridge applications
- RS485 communication with optimized network for high-speed transmission of synchronized measurements, to guarantee the indicator display high reactivity (25 meas/s with IPE100 terminal and 6 CB50X-DL connected).

CB50X & CB50X-DL behaviour in real use, comparison with competitor load cells

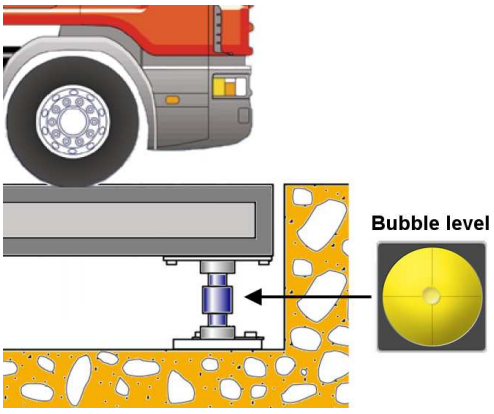
To test compression load cells behaviour in real condition, we use a weighbridge allowing the mounting of 4 or 6 load cells. For comparison, we've tested on the same condition the following column compression load cells :

SCAIME		FLINTEC
		
CB50X 30t C4	CB50X-DL 30t C4	RC3 30t C4

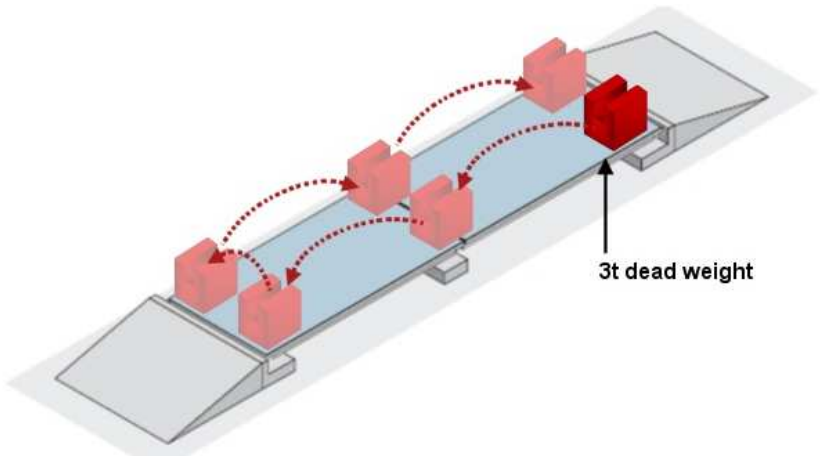
Load cells signal adjustment

For this test, we use our weighbridge with 6 load cells and an IPE100 weighing terminal

- The load cells are connected directly to the IPE100 without using trimming resistors.
- The load cells are installed at the same level, in perfect vertical position.
- We alternatively place a 3 tons dead weight at each weighbridge corner and read the weight on the IPE100.



Load cells mounting



Test procedure

Results

The following data show the maximum difference between the 6 measurement reading corresponding to the 6 positions of the 3 tons dead weight.

SCAIME		FLINTEC
CB50X 30t C4	CB50X-DL 30t C4	RC3 30t C4
3 kg	**1,5 kg**	**8 kg**

Conclusion

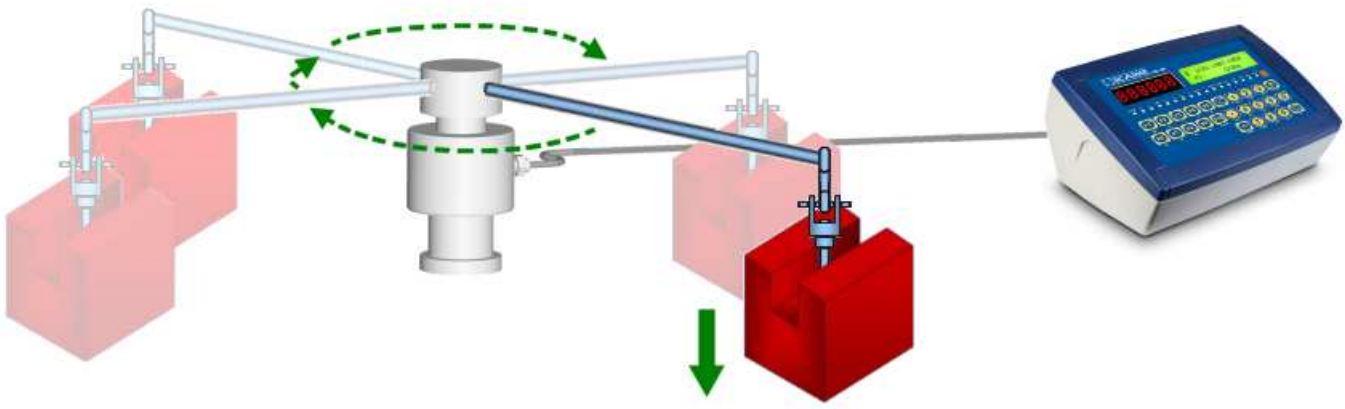
The signal output adjustment of SCAIME load cells is better than FLINTEC RC3 load cells.

In good weighbridge mounting condition, corner adjustment is useless with SCAIME load cells.

Load cells off-center compensation

The off-center compensation of the compression load cells is important when the weighbridge deck bend under load. If the load cells are not compensated, a loss of accuracy appears depending on the load position on the weighbridge deck.

For this test, we use a specific bench test generating a off-centered loading all around the load cell. The off-centered load is a 22.5kg dead weigh applied at 0.25m, representing a torsion force of 5.5 mkg.



Test procedure

Results

The following data show the maximum difference between the measurement readings corresponding to the positions of the dead weight.

SCAIME		FLINTEC
CB50X 30t C4	CB50X-DL 30t C4	RC3 30t C4
± 1 kg	**± 1 kg**	**± 1,9 kg**

Conclusion

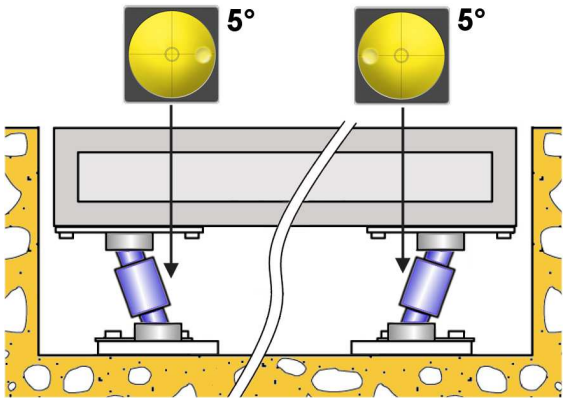
The mechanical off-center compensation of SCAIME load cells give a better result than patented electrical compensation of FLINTEC load cells.

Load cells behaviour in case on non vertical mounting

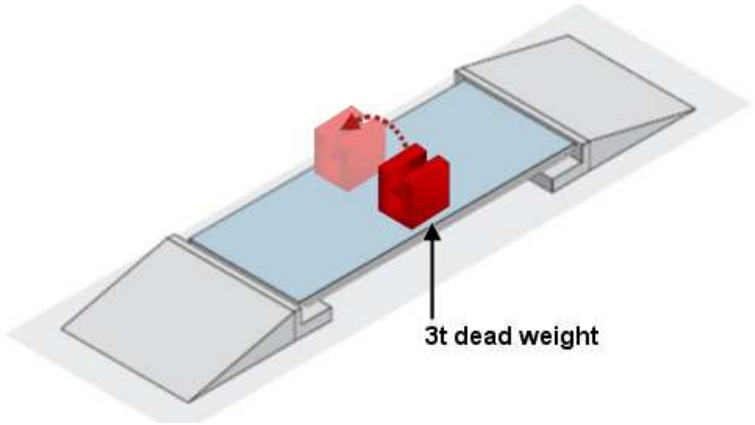
Although column compression load cells are designed to automatically restore the mounting construction to the initial position, if this initial position is not correct, the result will be a loss of accuracy. In particular it is a prime importance to Align the load cells vertically with an accurate bubble level.

The goal of the following test is to show the consequence when load cells in stable initial mounting are not in vertical position. For this test, we use a part of our weighbridge with 4 load cells and an IPE100 weighing terminal

- The load cells are connected directly to the IPE100 without using trimming resistors.
- The load cells are installed at the same level, in with **5°slope** from vertical position.
- By using a 3 tons dead weight placed on the weighbridge deck, we read the weight on the IPE100.



Load cells mounting



Test procedure

Results

The following data show the maximum difference between the measurement readings with the load cells installed with 5°slope and a previous measurement with load cells correctly installed.

SCAIME		FLINTEC
CB50X 30t C4	CB50X-DL 30t C4	RC3 30t C4
43 kg	**44 kg**	**42 kg**

Conclusion

These results show that checking the upright load cells position is necessary for accuracy.

you'll find a technical explanation to understand this outcome, common to all the column compression load cells, including FLINTEC RC3 load cells