# Frugal Load Cell Development using Axial Strain Gage and Reused Machine Parts

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## Introduction

Load cells are one of the most frequently used devices in physical verification and validation (PVV) and instrumentation industry for measuring loads. However, cost of load cells, set-up time and related human efforts are significant. Being frequent end users of load cells, authors were looking for an alternative to load cells to expediate the load measuring process.

Figure 1: Commercial Load Cell

Authors have designed a new joint that will sustain same axial load as that of load cells. A combination of hand calculations and simple static structural analysis was used in designing the joint. A special type of strain gage, axial strain gage, was added to this joint to act as sensor. In this paper, authors will talk about design, manufacturing, and calibration of newly developed alternative for load cell.

In addition to this novel effort, authors will explain how creative re-use of existing machine parts from shop and an axial strain gage can be used as alternative to load cells for measuring loads. Together, this combination saved 80% cost. The paper concludes with measurement correlation achieved between traditional load cell force measurement and frugal load cell force measurement with further application use of this newly developed alternative for load cell.

## Design and Validation of Frugal Load Cell

This frugal load cell is designed for known axial load by performing fundamental hand calculations for bolted joints. A hole of 3 mm diameter is made in the frugal load cell to put the axial strain gage sensor. Also, another horizontal hole of 2 mm diameter is made in the frugal load cell to take out wiring of the axial strain gage.

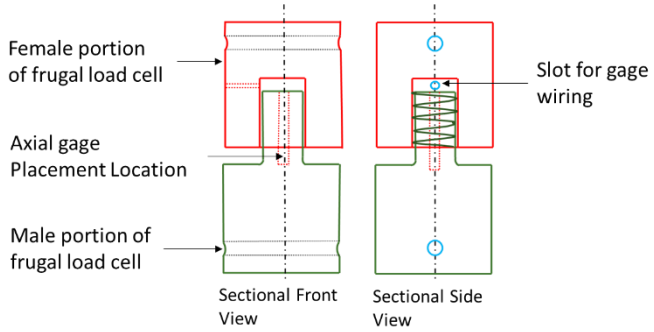


Figure 2: Frugal Load Cell Drawling

Designed frugal load cell and respective components are validated by performing virtual static structural analysis with known axial load. Also, the position of axial gage is determined through structural analysis in such way that, axial strain gage sensor will not have any effect due to localized geometric concentration and at the same time axial strain gage will observe finite response to known applied load.

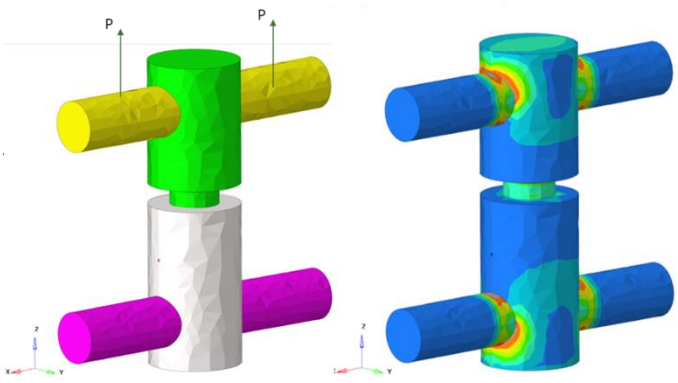


Figure 3: Virtual Analysis of Frugal Load Cell

## Manufacturing of Frugal Load Cell:

An old pin from a scrapped machine is re-used and machined with designed frugal load cell parameters. Axial strain gage is placed as per above mentioned position with the help of adhesives and wirings are taken out with given provisions.

Figure 4: Re-used Machine Part from Inventory as Frugal Load Cell

## Test Set-up – Load Measurement

This section describes about test set up used to validate the designed frugal load cell. An axial strain gage placed inside the frugal load cell is calibrated with standard procedure to convert measured strain into load. As load cells are intended to use axial loads in the system, an arrangement is made between commercial load cell and frugal load cell to measure the same known applied axial load. In this arrangement, the commercial load cell and frugal load cell positioned in series within the load point (P) and ensured that their centerlines coincide with the centerline of the load point (P) as shown in below figure. Outputs of commercial load cell and frugal load cell are captured and stored with appropriate data acquisition system.

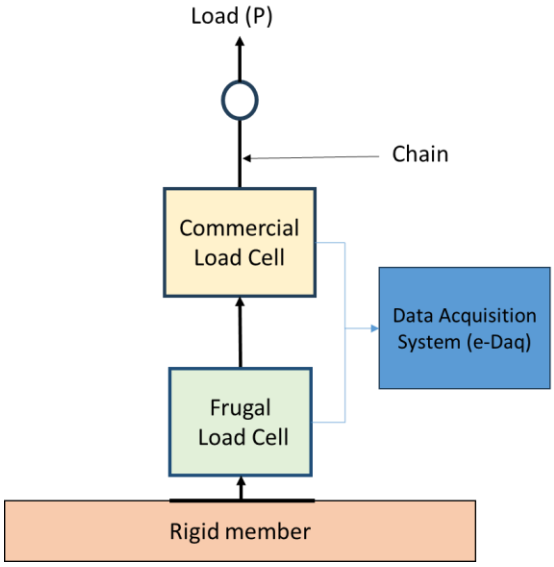


Figure 5: Test Set-up – Load Measurement

Prior to force application, ensured that the commercial load cell and frugal load cell pin showed zero readings and are stable when no load is applied. Gradually applied the force until required force and recorded responses for commercial load cell and frugal load cell simultaneously.

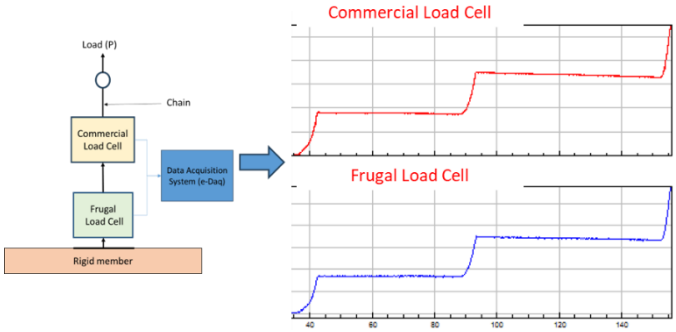


Figure 6: Response of Commercial Load Cell and Frugal Load Cell

## Correlation - Commercial Load Cell and Frugal Load Cell

This section describes the results along with correlation between commercial load cell and frugal load cell measurements. Measured responses of commercial load cell and frugal load cell were analyzed with appropriate data viewer.

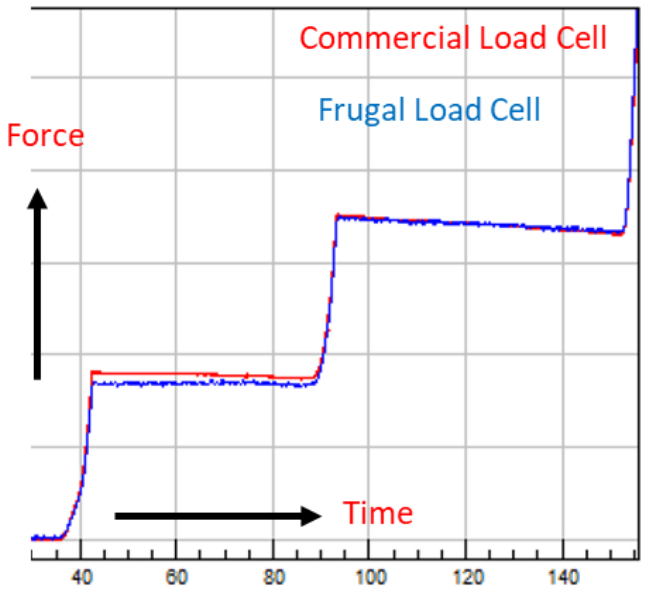


Figure 7: Re-used Machine Part from Inventory

It is observed that response of frugal load cell varied within 8% of commercial load cell. This variation is mainly observed in the beginning (between time of 40 to 80 sec) of load measurement and there was less than 3% variation after that. It is anticipated that; this variation is due to adhesive used to paste the axial stain gage in the frugal load cell which may be unstable in the beginning of the load measurement.

## Conclusion

Designed frugal load cell can be used in the applications where axial load measurement is required. Newly developed frugal load cell is providing cost benefit of nearly 80% over commercial load cell used in same application as this also involved creative re-use of ping from scrapped inventories.