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Implementation of On-Board Weighing System for Trailer Application

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Abstract

Now days, fast growth of the manufacturing industry is possible by rapid development and advancement in material handling equipment for their accurate and productive operations. There are different industrial sectors like timber, waste, aggregate, general trucking, mining; construction etc. uses the trailer for material handling. Some of the common problems are faced by such above applications like under loading, over loading, loading time loss, traffic fines, pay load over legal limits etc. The above problem can be eliminated by designing and implementing of on board weighing system.

Keywords: *Trailer, On-Board Monitoring, On-Board Weighing System, Weight Monitoring System*

1. Introduction

The trailer application generally used for the material handling operation in different industrial sector, but the ordinary trailer application poses basic problem about unknown weight so, there is a scope of design and implementation of trailer application by on board weighing system. The on board weighing system poses some basic features like low running cost, reducing loading time, adapted to any type of trailer or trolley. On-board weighing solutions can be implemented for all types of trucks and trailers. On-Board Scales help maximize your load while reducing costs keeping you in the profit zone, while avoiding over loading fines.

An onboard weight monitoring system displayed the true load weights on your onboard system at all times. In this on board weighing system weight is carried out by load cell mounted below the trailer platform and display actual weight on display board. Weighing system mainly consist of strain gauge which give the actual weight.

2. Experiment of Trailer

The on-board weighing system experiment perform on the small trailer used with 15 hp tractor for material handling with maximum loading capacity 1 ton. The existing small trailer design is very simple, and there is no arrangement for doing weight on trailer platform. The specifications of 15 hp mini tractor (figure 1) are given as below.

2.1 Tractor Specification

2.1.1 Weight of Tractor

- ✓ With Oil & Diesel 845 Kg
- ✓ Without Standard Ballast

2.1.2 Dimensions

- ✓ Length - 2286 Mm
- ✓ Width - 1016 Mm/1168 Mm
- ✓ Height - 1955 Mm with Exhaust Pipe
- ✓ Ground Clearance - 260 Mm
- ✓ Track Width - 812 Mm/965 Mm (Driving Wheels)
- ✓ Track Width - 902 Mm (Steering Wheels)

2.1.3 Transmission

- ✓ Minimum Turning Radius - 2.6 Meters (With Brakes), 2.8 Meters (Without Brakes)

Fig. 1 15 HP Mini Tractor

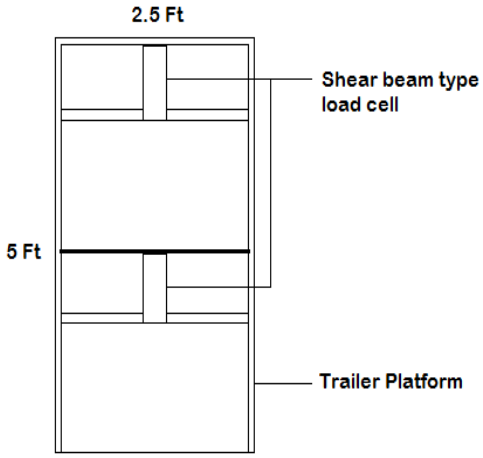

Fig. 2 Trailer Design

2.2 Existing Trailer Specification

- ✓ Length: 5ft
- ✓ Width: 2.5ft
- ✓ Height: 1ft
- ✓ Axel: Single
- ✓ Chassis: Three, Size 3 x 1.5 inch
- ✓ Wheel: Two
- ✓ Pay Load: 1 tone
- ✓ Hydraulic pump: 1 tone capacity

2.3 Implementation of Trailer Design

Now this Existing trailer is implemented by designing a Shear beam type two Load Cell, with changes in trailer design. Implemented Trailer design and two load cell exact position shown in figure.2. In this design making one more platform, which is fitted on two load cell mounted on the trailer fixed platform.

2.4 Load Cell Design

Load cell description, feature, electrical connection, technical specification, and construction diagram are described below.

2.4.1 Description

This is a strain gage based, single ended shear beam load cell designed for multiple uses in low profile platform scales & in tank, trailer, bin and hopper weighing systems. It is constructed from high alloy tool Steel for excellent resistance to shock and overload. The cell is sealed against moisture ingression for use in wash-down areas and it is electro less nickel plated for corrosion resistance [3]. It is low cost ideal load cell for industrial automation applications. Figure 3 shows the electrical connection and figure 4 shows the load cell diagram.

2.4.2 Feature

- ✓ 100 Kg to 10000 Kg capacities offered.
- ✓ Complete environmental protection.
- ✓ Protection available optionally with laser welded sealing.
- ✓ Standardized output (3.0 ± 0.25%) available on request.

2.4.3 Electrical Connection

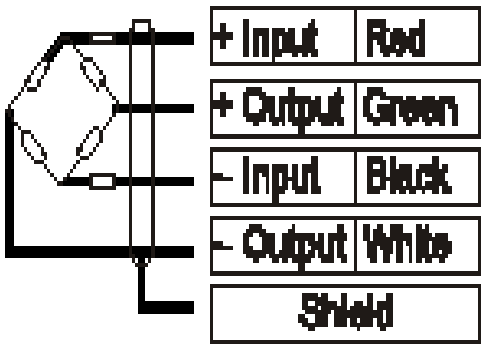

Fig. 3 Electrical Connection

2.4.4 Technical Specification

Table 1 Technical Specification

Standard Capacities	100, 200, 300,500 Kg 1, 2, 3, 5, 7.5, 10 Tone.
Excitation Voltage	10 VDC to15 VDC
Nominal Output	3.0 m V/ V
Non – Linearity	< ±0.025% FSO
Hysteresis	< ±0.02% FSO
Non-Repeatability	< ±0.01% FSO
Creep (30 minutes)	< ±0.03% FSO
Zero Balance	±1.0% FSO
Input Resistance	390 ± 3.5 Ohms
Output Resistance	350 ± 3.5 Ohms
Insulation Resistance (50 VDC)	> 1000 Mega Ohms
Cable Length (4 Core Screened)	5 meter. Minimum
Safe Overload of Rated Capacity	150%
Ultimate Overload of Rated Capacity	300%
Side Load Discrimination	500 : 1
Temp. Compensated Range	0-60 ^{0}C
Temperature Effect on Output	< 0.0015% ^{0}C
Temperature Effect on Zero	< 0.0020% ^{0}C
Deflection	< 0.5 mm at FSO
Tightening Torque	See table below.
Finish & Construction	Electro less Nickel Plated Tool Steel SS-Stainless Steel-17-4 PH
Environmental Protection Class	Available optionally with laser welding.

2.4.5 Construction Drawing

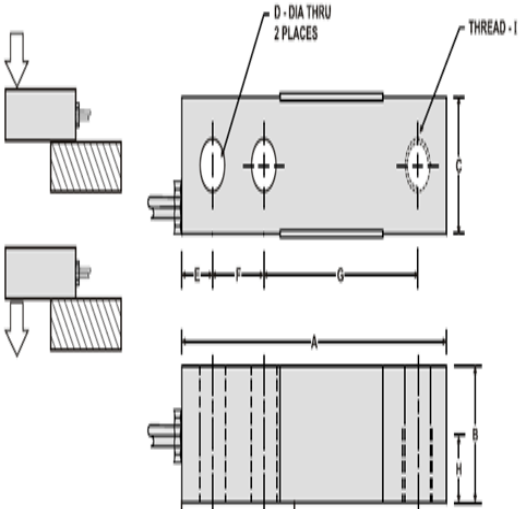

Fig. 4 Load Cell Diagram

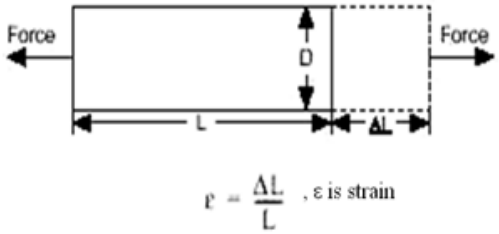

Fig. 5 Working of Strain Gauge

3. Working of Strain Gauge

Strain is the amount of deformation of a body due to an applied force. More specifically, strain (e) is defined as the fractional change in length. A strain gauge is a device whose electrical resistance varies in proportion to the amount of strain in the device which is shown in figure 5. The most widely used gauge is the bonded metallic strain gauge [2].

A length change of a wire causes a resistance change, which is measured by a strain gauge [4].

$$R = \frac{\rho L}{A}$$

Where, R = Resistance
ρ = Resistivity (Materialistic Property)
L = Length of Wire
A = Area of Wire

Change of Resistance,

$$dR = \frac{\delta R}{\delta \rho} d\rho + \frac{\delta R}{\delta L} dL + \frac{\delta R}{\delta A} dA$$

$$V = \frac{Transverse\ Starin}{Longitudinal\ Strain} = -\frac{\varepsilon t}{\varepsilon l} = \frac{\frac{-1}{2} * \frac{dA}{A}}{dL/_L}$$

Gauge Factor,

$$G.F. = \frac{\Delta R/_R}{\Delta L/_L} = \frac{\Delta R/_R}{\varepsilon}$$

The G.F. relates a change in resistance with strain, for most elements, G.F. ranges from 2.0-4.0 e.g., constantan = 2.0, Nichrome = 2.2 [2].

4. Measurement of Load on Trailer

Imagine your truck without a speedometer. It would be complicated and stressful especially at control points. Well, it's the same for your load, if you have no device monitoring your load weight; you are working blindly. An onboard weight monitoring system eliminates that problem. Now, the true load weights are displayed on your onboard system at all times. In this on board weighing system weight is carried out by Load Cell mounted below the trailer platform and display actual weight on display board, which is shown in figure 6 [1]. Weighing system mainly consist of strain gauge which give the actual weight [4].

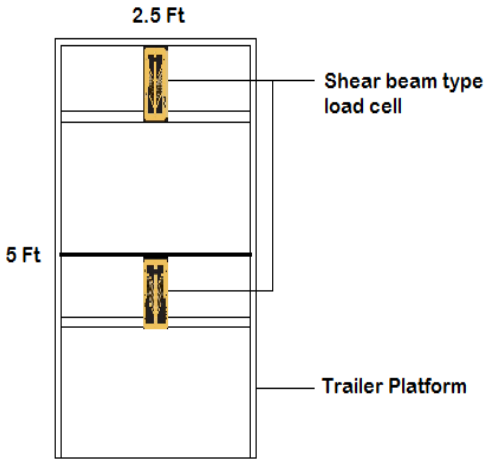

Fig. 6 Load Cell Mounting

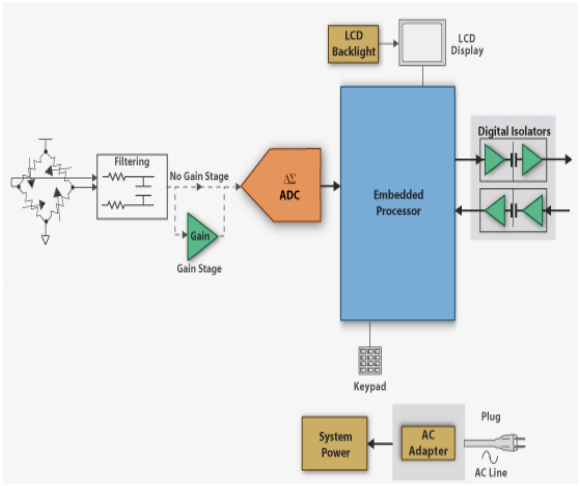

Fig. 7 Schematic Diagram

Now, when weight place on the trailer platform at that time metallic foil gauges are stretched, and resistance of the circuit are also change. Gain is produced in the form of analog signal. That signals filter or conditioning by the instrumentation amplifier, and converted by the ADC in to digital signals, and sends it to the embedded processor, than display on the LED display or LCD display [5]. Here system power supply to strain gauges, embedded processor, and display board from the trailer battery source or 12v Battery fitted with control box, which are shown in schematic diagram in figure 7.

5. Result of On-Board Weight

By this method, weighing is done on the trailer platform with more accuracy, and any time you know the current weight put on the trailer as shown in figure 8. Result of weight is done by putting different weights at five different positions on trailer platform, and its result shown in table 2.

Fig. 8 On-Board Trailer Application

Table 2 Result of On-Board Weight

NO.	WEIGHT	POSITION	RESULTS
1	200 Kg	Upper left	±199.97 Kg
		Upper right	±199.97 Kg
		Lower left	±200.00 Kg
		Lower right	±200.00 Kg
		Centre point	±200.00 Kg
2	400 Kg	Upper left	±399.98 Kg
		Upper right	±399.98 Kg
		Lower left	±400.00 Kg
		Lower right	±400.00 Kg
		Centre point	±400.00 Kg
3	600 Kg	Upper left	±599.99 Kg
		Upper right	±599.00 Kg
		Lower left	±600.00 Kg
		Lower right	±600.00 Kg
		Centre point	±600.00 Kg

No more uses of the weighbridge to monitor the weight load, No more premature wear damage caused by overloads, No more stress. The on board weighing system poses some basic features like low running cost, reducing loading time, adapted to any type of truck trailer or trolley.

6. Conclusion

On board weighing enables you to carry maximum payload within legal limits, eliminates overloading and traffic fines, reduced loading times, compatible and interchangeable with most tipping vehicles, low running costs, adapted to any types of trucks. In future work, the whole system uncertainty will be verified under known or controlled conditions to determine the accuracy of the measuring system. Moreover, strong wind will shake trailers, which leads to flickering of displayed data, making data reading difficult. Therefore weather condition and temperature must be considered.

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