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Development and Analysis of Automated Weighing System in Cargo Vehicles for Effective Supply Chain Management

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ABSTRACT: Today we have stepped into the 21st century, and our science and technology should be abreast with the fast growing world. New developments in sensing technologies have emerged in response to the ever-increasing demand for solutions of specific monitoring applications. So we planned to design such a monitoring device with the help of the sensors and microcontrollers. Today the vehicle consists of several provisions to monitor the condition of the vehicle during travelling and even in static position also. The dash board of the vehicle consists of the odometer, fuel level indicator, speedometer and many other required details. But there is no provision for the weight measuring in the vehicles. This weight of the vehicle is the most important one because each vehicle is designed to withstand certain load. Beyond that limit the vehicle gets failure. So to reduce that and identify the actual weight of the vehicle we designed an on-board weighing system for a highway cargo truck. This system consists if strain gauge fixed at the chassis of the truck and also a microcontroller to control all the electronic operations. The strain gauge produces deflection based on the amount of load in the truck; this causes resistances variation the strain gauge. This variation in resistance is directly proportional to the weight of the cargo in the truck. This is analog signal which is processed by the microcontroller and displayed in the liquid crystal display which is fixed at the dashboard. This is one of the mechatronic based automation system. This paves way to supply the goods to the customers in time effectively.

KEYWORDS: Automated weighing system, on-board, Supply Chain Management

I. INTRODUCTION

The rapid growth in science and technologies has revolutionized the entire life the human being. Each and every activity of the humans were made quite simple due to the advancements in science. This rapid growth made the man to think innovatively and lively which enables him to create new things or also induces him to modify the older methodologies. Nowadays the automation becomes the major part of any industry. This automation is also introduced in the automobile sectors to make new design and to optimize the manufacturing processes. Electronics are the major boon for this automation, without these it is not possible. Sensors and transducers are the major electronics which paved the way for the successful automation. New developments in sensing technologies have emerged in response to the ever-increasing demand for solutions of specific monitoring applications. They have produced fast, more sensitive, and more precise measuring devices. The advancements in technology have made life simpler and easier. The problems in the conventional designs have led to new and exciting innovations.

The onboard weighing systems have revolutionized the method of payload measurement. This innovation made the weighing system in a cargo truck very simpler and even cheaper too. The equipment is designed to indicate the payload of a cargo truck at any instant of time without the help of a weighing bridge.

Load on the present automobiles on Indian roads is measured in a weighbridge. When considering which type of weighing machine to use for our own particular operation, it is important to take in to account.

- The amount of weighing expected.
- The type of vehicle to be weighed.

Today the electronic devices have replaced the electromechanical and mechanical devices due to their accuracy and simplicity. The emphasis on quality is matched with the expectations that electronic goods will be manufactured with ever increasing capability at lower cost.

Microcontroller based design has many advantages such as its flexible development time is less and cost is less. This project uses Pic16F870 and strain gauge as a sensor.

Depending on the stress on the vehicle of the chassis it undergoes strain and this strain is sensed by the strain gauge.

The output of the strain gauge varies proportional to load applied on the chassis. The signal from the sensor is processed in the microcontroller and weight is displayed in the LCD.

**System Description
Block Diagram**

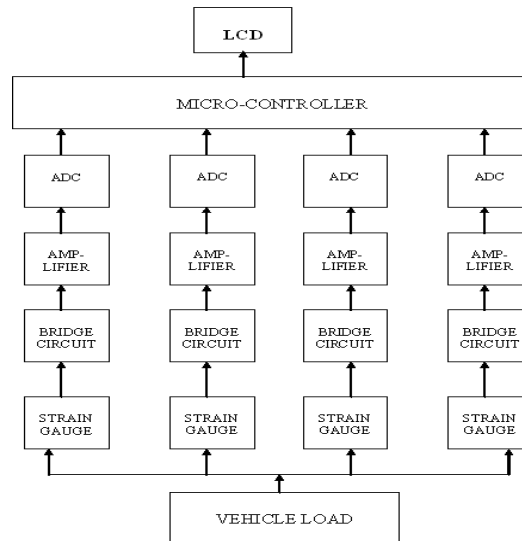


Fig 1. Block diagram of the system

II. REVIEW OF LITERATURE

Stress-tek, Inc. is the manufacturer of Vulcan On-Board scales. These scales have been installed on over 20000 vehicles. This design and manufacture solutions for spring, air, and mixed spring/air suspensions. Their sensors provide a broad range of options to fit a wide variety of tractors and trailer configuration across multiple industries.

Stress –Tex load cells do not have moving parts, and use bonded foil strain gauges as the sensing element. Typically, four gauges are used in a wheat stone bridge configuration. The strain gauges change electrical resistance when the cell is slightly deformed by load. This deformation produces voltage signal that is proportional to the load. The signal is then used as a measure of weight, force or deflection. This valuable information can then be used to improve the efficiency and safety of operation.

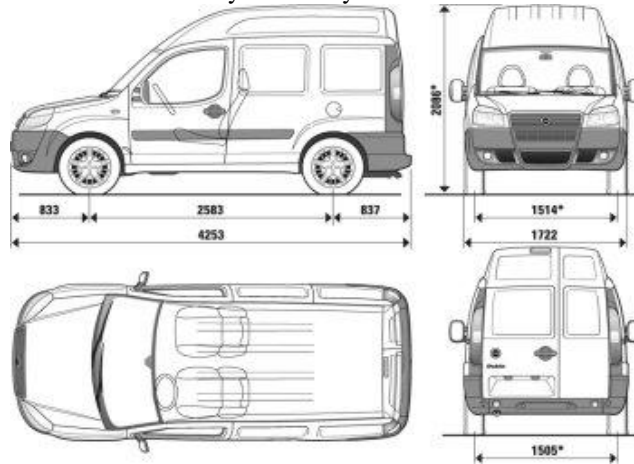
Data’s are collected related to the **Truck Body Building** regulations from Road transport office, which helps to acquire idea for mounting the sensor.

Overall Dimension of the truck

S.no	Overall length of the vehicles.	Length of the vehicles Shall not exceed(mm)
1.	Other than transport vehicles having not more than 2 axles.	9500
2.	Transport vehicles having two or more axle.	112500
3.	Articulated vehicles having more than 2 axles.	16000
4.	Truck-trailer, tractor trailer combination.	18000
5.	Trailer carrying ISO series I freight.	4200

Table. Overall dimension table of the truck

The chassis specifications for Honda’s Acty Open Cargo were as follows, this open cargo is the ideal vehicle for carrying large volume as well as tall loads smoothly and easily.



Major Dimensions

(For Chassis in mm)

Wheel base	:	3886
Front overhang	:	870
Rear overhang	:	1006
Overall length	:	3600

III. EXPERIMENTAL SETUP / DESIGN OF EXPERIMENTS

3.1. Methodology - I

The researchers had made a study on the truck and this study enables them to conclude that the king pin of the leaf spring can be replaced with the load pin. The four wheels of the cargo vehicle hold the total payload of the vehicle. Leaf springs are provided on the four wheels of the truck to avoid the shocks and impact. The king pin connects the leaf springs and the chassis. The load of the truck acts perpendicular to the axis of the king pin.

Initially the study about the reliability of the pin was made by approaching the truck workshop. From there the researcher came to know that with proper loading and lubrication the king pin will last for 1 year without damage. Taking all this into consideration a pin diagram was drawn as per requirement.

The following diagram shows the outline sketch of the load pin.

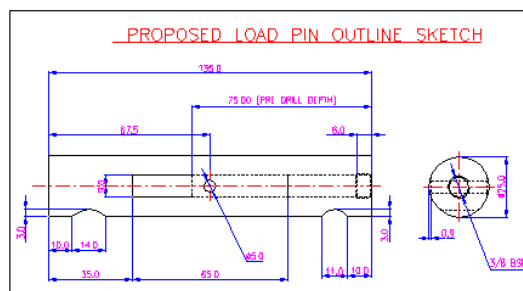


Fig Load pin outline sketch

The load pin is provided with a small internal hole (lubricating hole) with a diameter of 8mm which is essential to lubricate and also to avoid friction between leaf spring and king pin. The load pin for this application is not available in the market and also it has the manufacturing problem because of the presence of the internal lubricating hole.

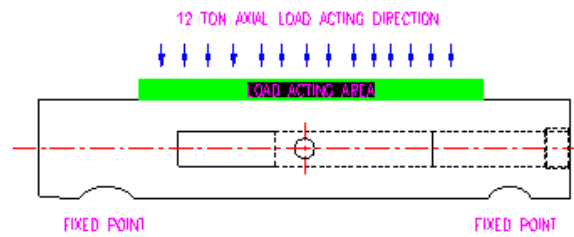


Fig 3.2 Load acting sketch of load pin

3.3. Methodology – II

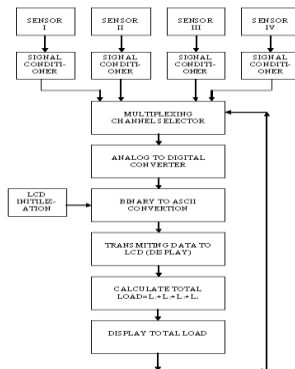
The principle of strain gauge helped to develop an idea of bonding the strain gauge in the chassis of the truck to measure the chassis deflection for the various loads. The strain gauge is bonded on the maximum deflecting point of the chassis and the output from the strain gauge is measured.

Truck details

- The capacity of the truck is = 13500 kgs
- The distance between the two wheels is = 2250mm
- The total length of the chassis is = 3400mm

The load was considered as a point load because the load of the truck was supported on the 4 points of wooden cross members. By using the Macaulay’s method the deflection of the beam is calculated for bonding the strain gauge at the maximum deflecting area.

**Software Descriptions
Flow Chart**



FLOW CHART – MULTIPLEXING

Sl. No.	Load in Kg	Output in Volt
1.	0	0.1
2.	500	0.44
3.	2750	1.5
4.	4500	2.3
5.	9000	3.4
6.	13500	4.2

Table Look up table

IV. RESULTS AND DISCUSSION

In this work several attempts were made to mount various weights measuring system in the cargo truck. The strain gauge method of weighing helped to develop the weighing system. When the strain gauge is deformed by the load then

the electrical resistance is produced. This deformation produces a voltage signal that is proportional to the load. This analog voltage signal is converted into a digital signal for processing in the micro controller and displayed in the LCD.

4.1 Cost analysis

Truck owner per month cost for 6 wheelers for 20 tones = 100*35 = Rs 3500
 Truck owner per year cost for 6 wheelers for 20 tones = 3500*12 = Rs 42000

On an average a truck owner goes to weighbridge at least 100 times in a month. He spends Rs. 35 for weighing once with the load. So for weighing he spends Rs. 42000 per year.

4.2 Error analysis

$$\% \text{ Error} = \frac{\text{Actual Value} - \text{Measured Value}}{\text{Actual value}} * 100$$

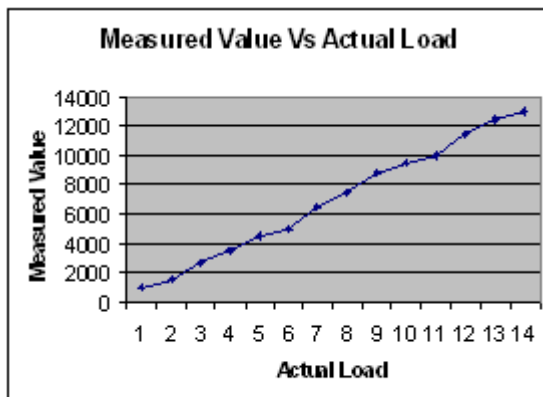


Fig. Measured Value Vs Actual Load.

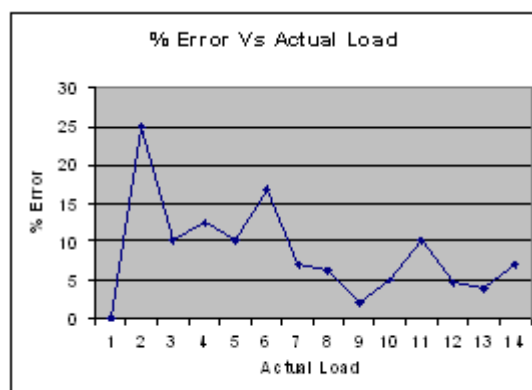


Fig. 20 % of Error Vs Actual Load

V. CONCLUSION

This work “Design of on board weighing system for a highway cargo truck “is designed for use in all vehicles. The payload indicator and the strain gauge were cheaper when compared to the cost incurred for frequent measuring in the weighbridge. It benefits the driver of the vehicle to adjust himself to various traffic conditions to prevent accidents. The accuracy and the closeness of the displayed data can be varied by simple software modifications. This onboard weighing system is developed in such a way that facilities available in it can be expanded in future also.

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