AXLE WEIGHING SYSTEM

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Abstract
The paper presents the layout of the axle weighing system. The implementation of this equipment resulted from the requirement to measure and verify the mass of vehicles dispatching different kinds of loads from the several workplaces. In the past, the control measurement had been carried out by one above-ground weighbridge mounted at one workstation, but the increasing number of temporary workplaces resulted in the operational weighing of vehicles needs.
There were established the following standard criteria in the development - the cost of the entire project, operation of the equipment, the weight and mobility of the equipment.

Key words: *Axle weighing scale, Strain gauge, Vehicle*

INTRODUCTION

The axle weighing system is used for measuring the weight of motor vehicle, truck or semi-trailer. It consists of the axle weighing scales (2pcs for the weighted axle of the vehicle) and the evaluation unit. The axle scale consists of an aluminium weighing bridge installed on four or six strain gauge sensors. The measuring range is 3t, 6t, 10t, 12t, or 20t. The ramps provide the smooth passage through the axle scale. The evaluation unit is placed in a portable case for reasons of safety and mobility. During the measurement, it processes the generated electrical signal from the scales with which the evaluation unit is connected via cables with a length of up to 10 m or via WiFi. The resulting weight value is shown on the display and then printed as a measurement record.
There is used the static or dynamic method for the vehicle weighing. The static method requires the scale must be placed under each wheel of the vehicle. The gravity of each wheel is measured at the time interval of 10 seconds. For weighing by the dynamic method, two scales are placed on the fixed floor at a distance according to the axle wheel gauge. The vehicle must pass through the wheels of each axle through the axle weighing scales at a speed of up to 5 km.h-1 at the time interval of 30 or 60 seconds. The resulting mass of the vehicle is determined from the time course. (Málik, 2013)

MATERIALS AND METHODS

Development of the axle weighing system

The following requirements must be taken into account in the development of the axle weighing system:

- the measuring range of the axle weighing scale - 9 tons per wheel,
- maximum scale dimensions with ramps (W x L x H) 500 x 1200 x 70 [mm],
- measurement of the 2, 3 – axle vehicles up to 40 tonnes,
- usability of stock materials
- productivity in the company's production capabilities,
- mobile and simple handling
- the cost of the whole project

RESULTS AND DISCUSSION

The variant layout

The variant of the weighing system is proposed for these requirements. It consists of the axle weighing scale disposition and control unit.

The road axle weighing scale displacement

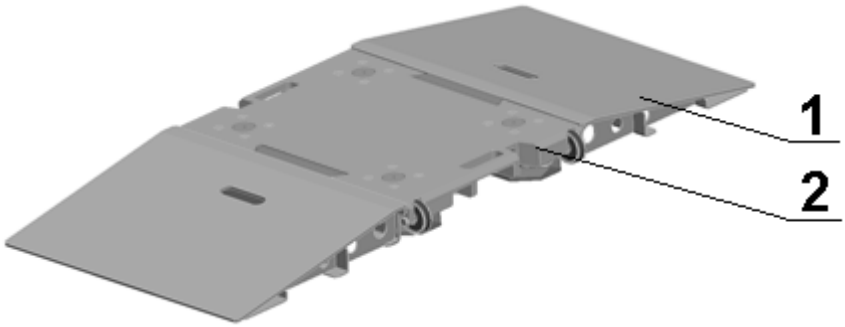
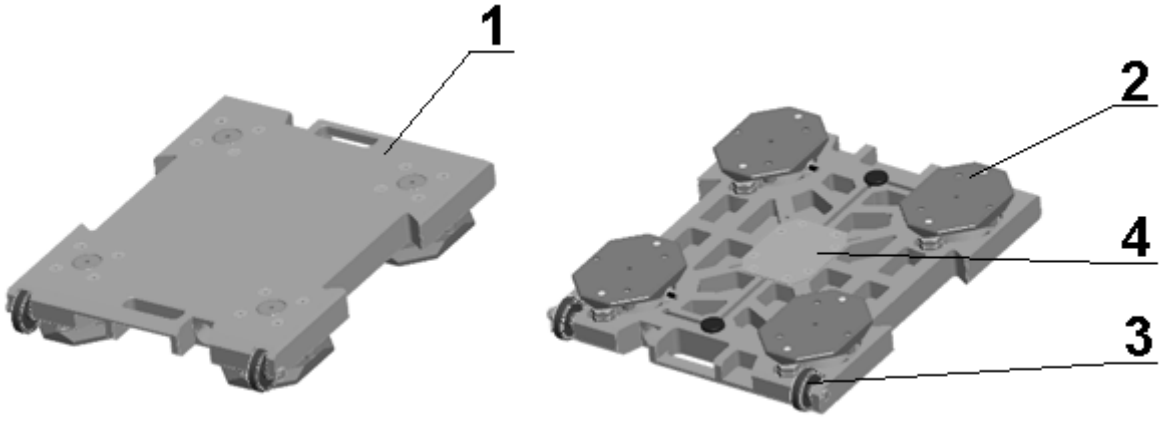


Fig. 1 Axle weighing scale

The weigh bridge of the axle weighing scale is the aluminium plate with dimensions of 500 x 400 x 40 mm. The relief grooves in order to reduce weight, two sliding locks for insuring the ramps against shifting and two handles are provided in the plate. On the right side of the scale, two traversing wheels are attached for its simplified manipulation. Four strain gauge housings are attached to the bridge using screw connections. (Kohár, 2015)

The weighing bridge was tested by the Ansys Workbench program. The crossing of the truck's rear wheel through the scale was simulated. The steering force generated by the wheel was 120,000.0 N. The bridge was fixed by fixed support. The result was total deformation of the plate 0,7 mm and equivalent stress 72 MPa. The resulting value of the simulated deflection fulfilled the condition of the maximum allowable deflection l/250 = 1,1 mm. (Kohár, et al., 2016)

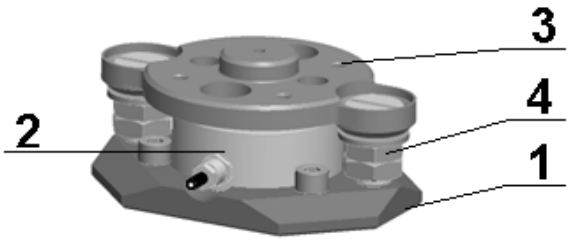


1- bridge, 2- strain gauge housings, 3- wheel, 4- sheet (connecting block cover)

Fig. 2 Axle weighing scale displacement

The weighing system

The weighing system consists of four strain gauge housings. The each strain gauge housing pedestal has UTILCELL M420-2.5t strain gauge sensor operating in the piezoelectric principle. The strain gauge is secured against movement in the direction of the "x" and "y" axes using three screws deployed with a 120º rotation. The height of the pedestal against the floor is adjusted by the height of its top cover. It is set using two bolts, each with two nuts. A steel roller for one-point load force transfer is located between the strain gauge measuring area and the cover.(Tropp et al., 2016)



1- pedestal, 2- strain gauge M420, 3- cover,
4- adjusting bolt with nuts and support

Fig. 3 Strain gauge housing

Technical parameters of the axle weighing scale

Tab. 1 Technical parameters of the proposed axle scale

Description	Unit/characteristics
Weighing [kg]	9 000
Accuracy – division[kg]	5
Nominal sensitivity [mV/ V]	2 ± 0,1 %
Function	weighing (static, dynamic)
Velocity of weighing [s]	≤ 10
Dimension of weighing area W x L [mm]	500 x 400
Dimensions of scales with ramps W x L x H [mm]	500 x 1200 x 70
Scale weight [kg]	42
Construction design	steel / aluminium
Operating temperature standard [°C]	-10 ÷ 40
Operating temperature limits [°C]	-50 ÷ 80
Data transfer	Via cable
Location	mobile
Protection	IP 68

Evaluation unit

The complex evaluation unit consists of the UTILCELL Matrix Digital electronics (communication with PC via USB port), I/O Card with 6 digital inputs and a small cash register printer. This apparatus is located in a safety case from firm and flexible copolymer resistant to mechanical shocks. The top of the unit covers the design panel. (Lukáč, et al., 2016)

Fig. 4 Evaluation unit

CONCLUSIONS

The axle weighing scale as a whole fulfills all the requirements specified by the contracting entity. The advantage of this scale is the mobile construction, easy assembly and its favorable acquisition price. It can weigh a vehicle with 2, 3 axles, the total weight of which does not exceed 40t.

ACKNOWLEDGMENT

We support research activities in Slovakia / project financed from EU funds.
This article was created by the project "ProHiSpeB - prototype of telematics axle bearing for high speeds" on the basis Operational Programme Research and Development funded by the European Regional Development Fund.

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