

Efficient Weight Enforcement with Portable HAENNI Wheel Load Scales

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1. The Road Network

1.1. Commercial Aspects

Goods are produced and must be transported to the customer. A prospering economy is not possible without a good road network.

1.2. Road Conservation, Prevention of Road Damages

The road network must be kept in a good condition to ensure, that it is able to fulfil its duty also in the future and for protection of the high investment cost. The main danger for the road is the destruction by overloaded heavy vehicles.

Road damages are the result of cracks in the foundation. The road engineers calculate the dimensions of the foundation according to the expected vehicle loads. As long as the loads of the vehicles passing by are lower than the expected maximum value, the only damage which occurs is the abrasion of the road surface. In the case of minor overloads only occasional cracks will occur. With the time the Number of cracks increases until the damage of the road is visible at the surface. The higher the overload the faster the road is destroyed. The influence is heavily non-linear (power 4 function).

As a comparison one can imagine a rope of a crane. As long as the maximum load is respected the lifetime is almost indefinite. Occasional overloads result in some minor non-elastic deformations until the rope breaks (so called fatigue). One heavy overload will break the rope at once!

1.3. Accident Prevention

Overloaded vehicles are a safety risk! It may result in failures of the breaks, skidding accidents and so on.

1.4. Fair Competition

The more a vehicle is loaded, the cheaper the transportation cost is. Companies with overloaded vehicles make more profit by illegal behaviour. In the interest of a fair competition this must be avoided!

1.5. Public Information

Weight enforcement is much more accepted by the society and the transportation industry, if they know the reason why. In many cases an initial dislike of a transportation company changes to a wide acceptance, because they realise, that only unfair competition is punished.

1.6. Commercial Aspects from the Point of View of the Transportation Industry

Damages of the road network by overloaded trucks result in higher medium term cost for the transportation industry, because the government is not always able to repair the roads in a reasonable time. The results are longer transportation times and higher cost for service and repair of the vehicles. The wear of the suspensions and the tyres increases as well as the fuel consumption. Beside that, the actual trend is to charge the responsible party for all costs arising by its activities. That means that more and more governments are going to charge the heavy traffic for paying the road damages.

2. Legal Aspects

2.1. Basic Regulations for scales (OIML)

The OIML (Organisation Internationale de Métrologie Légale) is an international Organisation, which establishes world wide accepted recommendations for measuring equipment in legal applications.

2.2. National Regulations

2.2.1. Regulations for the Gross and Axle Weight

In the law of most countries, regulations for the gross weight and the axle weights are established. But there are also some countries without such regulations. The limits in the individual countries are quite different, according to their philosophy, topographic shape and to their economic situation. Example: Switzerland till 2000 (Narrow valleys, mountains, short distances, good railway system): Gross weight: 28t, axle weight: 10/11t, Australia (long distances, lots of dirt roads, almost no railway system): Gross weight: 115t, axle weight: 9t!

2.2.2. Regulations for the Measuring Equipment

Most countries have adopted the OIML regulations in their body of law, some with minor changes. In addition usually also a rule for the police for the proper use of the wheel load scales is issued. It is covering how to avoid additional errors caused by unfavourable properties of the vehicle and of the weighing site, how to calculate the gross vehicle mass based on axle by axle weighings, tolerance deductions, etc.

2.3. Approval for the Weighing Equipment

To make sure, that the weighing instrument complies with the regulations, usually one sample instrument has to be tested 100% by the national body of weights and measures (Accuracy in the whole temperature range, repeatability, creep, tilting, eccentric load, electromagnetic interference and so on). The complete test takes about 4 weeks! Without an approval it is not possible to put a weighing instrument into operation for legal application.

In many cases the test results of foreign countries are accepted by the national authorities. In this case the issue of the approval is only an administrative matter. There are the following four possibilities to get an approval:

- The **national authorities accept an OIML certificate**, which confirms that the instrument complies with the appropriate OIML recommendations. Only a few countries that are equipped with necessary test facilities are entitled to issue such certificates (Refer also to section 2.4.2.). All member states of OIML should principally accept an OIML certificate.
- The **complete approval of a foreign country is accepted** by the national authorities.
- The **test results of a foreign country are accepted**. The national body of weights and measures only checks for compliance with the national regulations. If individual tests have not been performed or do not comply with the national regulations, these tests may be repeated.
- **All tests** are performed by the **national body of weights and measures**, according to the national regulations.

Before putting into operation each individual scale has to be tested by a laboratory of the national body of weight and measures. This test is much simpler. It consists of checking whether the instrument is identical with the fully tested sample and of an accuracy test at ambient temperature. After the test is passed the instrument gets stamped and may then be put into operation.

In this context it is important to know, that some manufacturer, whose products are **not approved**, specify the technical data **according to OIML**. For Instance: „Accuracy according OIML No. 76“. The proper interpretation is, that the **manufacturer** guarantees only some technical specifications, but it does not say that the instrument has passed or is able to pass a complete approval procedure.

2.4. The OIML Certificate of Conformity

2.4.1. What does the OIML Certificate of Conformity cover?

The OIML Certificate System for Measuring Instruments was introduced in 1991 to facilitate administrative procedures and to lower costs associated with the international trade of measuring instruments subject to legal requirements.

The System provides the possibility for a manufacturer to obtain an OIML certificate and a test report **indicating that a given instrument pattern complies with the requirements of relevant OIML International Recommendations**.

OIML certificates are accepted by national metrology services on a **voluntary basis**, and as the climate for mutual confidence and recognition of test results develops between OIML Members, the OIML Certificate System serves to simplify the pattern approval process for manufacturers and metrology authorities by eliminating costly duplication of application and test procedures.

2.4.2. Who is entitled to issue an OIML Certificate?

Certificates are issued by OIML Member States that have established one or more Issuing Authorities capable for processing applications by manufacturers wishing to have their instrument patterns certified. The following countries have established a testing and issuing authority for non automatic weighing instruments according Recommendation R 76:

Austria, Australia, Belgium, Bulgaria, Brazil, Switzerland, People's Rep. of China, Germany, Denmark, Spain, United Kingdom, Hungary, Japan, Rep. of Korea, Netherlands, Norway, Poland, Russia, Sweden and USA (Updated 2002.08).

2.4.3. Which HAENNI scales are OIML certified?

The static low profile scales WL 101 (mechanical) and the WL 103 (electronic) are OIML certified. They are listed under the following numbers:

WL 101: R76/1992-CH-96.01; WL 103: R76/1992-CH-97.01. Refer also to the OIML web page http://www.oiml.org/certificates/cert_english.htm

Up to date it is not possible to certify the dynamic Wheel Load Scale WL 110 because OIML has not yet issued a recommendation for such products. At the moment there is only a draft available for fixed installed dynamic scales and only for weighing the gross vehicle weight. The work for integrating also the axle load is in progress, but there is no recommendation in sight for mobile equipment!

2.4.4. What are the benefits of the OIML Certificate?

Having an OIML Certificate of Conformity is a valuable proof of quality, because it shows, that the product has been tested by a renowned Organisation according to the very detailed and demanding OIML Recommendation R 76.

It saves time and money in the case that the OIML Certificate is accepted by the national weight and measures body for issuing the National Approval.

If the national weights and measures body do not accept the OIML Certificate it is still a valuable instrument to reduce the risk of bad testing results. Testing of low profile scales needs some specific precautions in order to get correct results. Refer to P 1133. The testing results might be bad if the weights and measures body do not respect these precautions. If they are aware that the product previously has been OIML certified they rather tend to question their own results.

3. Wheel Load Scales

3.1. Static / Dynamic Weighing

Most scales are static scales. That means that the user has to wait until the applied load has stabilised and the indication is stable. The big advantage is that all error influences due to dynamic forces are suppressed. For this reason in most countries only static scales are used for law enforcement. It ensures that there is almost no chance to appeal in court.

Dynamic scales are able to determine the weight without the need to stop the vehicle on the platform. Therefore the traffic is not disturbed very much. The disadvantage is the lower accuracy due to the fact that a moving vehicle always is in an oscillating state. The worse the quality of the pavement and the higher the speed of the vehicle, the bigger the error of the indication! At 10 km/h on an average road the error is about $\pm 8\%$ for the axle load and about $\pm 5\%$ for the gross weight. Refer to P 1196 and P 1216

Dynamic scales are **good for statistics**, because a lot of vehicles can be weighed in a short time and because the average error gets smaller over a big number of measurements. Dynamic scales are also a very good solution for **pre-selection in law enforcement**. Only the selected vehicles are weighed on static scales.

3.2. The „Perfect“ Wheel Load Scale

The perfect wheel load scale is indefinitely thin, is equipped with a platform big enough for carrying a dual tyre wheel, is not sensitive for the surface shape of the pavement, is not sensitive for temperature changes and is almost indestructible.

The scale must be thin for an easy access and for an easy levelling of the wheels (refer also to the chapter „How to use portable wheel load scales“).

3.3. Different Types Wheel Load Scales

The perfect wheel load scale does not exist! Different designs are available on the market:

- Compact type (High and small platform. That means one tyre of a dual wheel is lifted off the ground). The first models of this type were introduced in the thirties. They still are on the market, but not for law enforcement. Advantage: Weighing is possible on all kind of surfaces. They may also be used for rigid items like containers.
- Low profile scales (low platform, big surface for carrying a full dual wheel). The first scales of this type have been launched in 1975 by HAENNI. The advantages are a very easy roll on, a light weight and a negligible change of the location of the centre of gravity

For weight enforcement only low profile scales are used today. The measurement is completed in a much shorter time, so that the traffic is not disturbed too much. The results are accurate enough for having no troubles in court.

The compact types are absolutely unsuitable, because it is very difficult to drive onto the platform with a fully loaded vehicle. Beside that the driver usually is not motivated to give his best, when he is checked by the police!

3.4. Advantages and Disadvantages of the various designs

Beside HAENNI also some other companies are selling low profile scales. Depending on their design they may have some disadvantages:

Feature: Platform as a freely suspended bending plate.

Disadvantage: The lower side of the platform may touch the ground when loaded (stones, other particles), due to the bending of the platform. The result is a far too low indication.

Heavy weight, because the platform must be quite thick to withstand the bending stress.

To reduce the weight some executions are equipped with a smaller platform. Dual tyres are not placed completely on the platform. The overhanging part of the tyre may touch the ground. The result is a far too low indication.

Feature: Wireless communication.

Disadvantage: Disturbance by radio and mobile phones.

Feature: Weight measurement by strain gauges integrated in the bending plate.

Disadvantage: The Indication may be influenced by the surface shape of the measuring site.

Feature: Cast aluminium platform.

Disadvantage: May break on uneven surface.

Feature: AAA size Batteries

Disadvantage: Short operating time, approximately 8h.

Feature: No display on the scale

Disadvantage: The scale can not be used as a standalone instrument.

3.5. The HAENNI wheel Load Scales

The HAENNI low profile scales are free of the above listed disadvantages, because of their specialised and patented design. The Advantages are:

WL 101 (static):

- Measuring range 0...10 t and 0...15t; division 50 kg
- Large Temperature range: -20 °C ...+60 °C
- Very low profile: 17 mm
- Low weight: 15 kg
- Indication not sensitive to uneven surface.
- World wide approvals based on OIML
- Despite the low profile very rugged design
- Long lifetime, free of fatigue
- Self-contained
- Additional features refer to the data sheet.

WL 103 (static):

- Measuring range 0...2t, division 10 kg; 0...10 t, division 20 and 50 kg; 0...15t, division 50 kg
- Large Temperature range: -20 °C ...+60 °C
- Very low profile: 17 mm
- Low weight: 17 kg
- Indication not sensitive to uneven surface.
- World wide approvals based on OIML
- Despite the low profile very rugged design
- Long lifetime, free of fatigue
- Operational for 60 h per battery charge
- May be used as an axle load scale if connected together by a cable
- May be connected to a separate processing unit or to a personal computer
- Additional features refer to the data sheet.

WL 110 (dynamic):

- Measuring range 0...10 t
- Display and printout of the weights on a separate processing unit
- Large Temperature range: -20 °C ...+60 °C
- Extremely low profile: 11 mm
- Low weight: 17 kg
- Indication not sensitive to uneven surface.
- Self-contained
- Perfect for Pre-Selection

4. Vehicle Weight Enforcement by the Police

4.1. General

To protect the road network from destruction, the government can take into consideration the following means:

- Setting up weight limits for the heavy traffic
- Appropriate design of the road
- Checking of weight of the heavy traffic by the police
- Setting up rules for fines for overweight

With these means the following scenarios are possible for an efficient protection of the road network:

- Design of the roads for far higher weights than stated in the law. No need for weight enforcement, because even the highest overloaded truck will not damage the road. The consequences are very high cost for the road construction
- Checking all vehicles which enter the road network to be protected (access control at the entrance gates of the highway. The costs are relatively high.
- Weight enforcement by spot checks. Many checks and low fines, or few checks with high fines.

4.2. Fixed Installations

Fixed installations are a good solution, if it is not possible for the driver to bypass the weighing site. Example: Toll gate on the high way, customs and so on.

4.3. Use of Portable Wheel Load Scales

In all other cases portable wheel load scales are favourable:

- The measurements are not limited to certain sites. The driver has no possibility to bypass the measuring point systematically.
- The location of the measurement can be changed in a very short time. The experience shows, that after one hour the site must be changed, because the drivers are warned by their colleges by radio or mobile phone.
- Longer operating time of the scales because the scale goes with the personnel.
- Lower cost
- The weight enforcement can be combined easily with other checks (Rest times of the driver, check of the goods and the papers, vehicle dimensions and so on).

4.4. Portable wheel load scales in comparison with a fixed installation / Advantages

<u>Use of portable wheel load scales</u>	<u>Fixed installations</u>
No civil works	Considerable civil works
Low investment cost	High investment cost.
Long operation time, because the scales are moving with the personnel	Only part time operation.
Fast exchange in case of failure. Specialised central service point.	Repair and service is possible only on site. Long down time.
Lower repair and service cost.	High repair and service cost.
Easy dislocation	Can hardly be dislocated
Storage at a save place	Exposed to vandalism
The weighing can be continued even in case of a failure of one component.	A failure of one component stops the weighing.

5. How to Use Portable Wheel Load Scales

The use of portable wheel load scales is very simple. Even with just two scales it is possible to determine accurately the weight of any kind of vehicle. The procedure is to weigh axle by axle. The scale shows the weight of the wheel placed on the platform. The sum of two wheels is the axle weight and the sum of the axle weights is the gross weight.

To obtain accurate results it is essential to follow certain rules and procedures. In the following sections the most important sources of errors and their remedies are listed.

Gradient of the measuring site:

Tilting of the vehicle results in a change of the location of the centre of gravity. The result is a changed repartition of the load on the individual wheels. This effect has to be taken into consideration when selecting a measuring site.

On a measuring site which is level in all directions, all wheel and axle loads and the gross weight are indicated without affect. If the site shows a gradient crosswise to the driving direction, then still the axle weights and the gross weight are unaffected, if the gradient is lengthways, then only the gross weight is unaffected.

Also the height of the scale influences the position of the centre of gravity. In the case of low profile scales the influence is negligible. But if two compact scales are used the effect is considerable. The only remedy is to bring all other wheels onto the same level by using more scales or levellers (dummies). The problem will then be that it is almost impossible to climb onto the scales simultaneously with all wheels.

Errors due to the characteristics of the suspension:

When measuring multi axle systems all wheels of this system must be exactly on the same level. Otherwise the height of the scale would force the measured wheel to be lifted, what may result in a higher force of the spring suspension. This

influence rises with the height of the scale. The factor may be up to 50 kg per mm, what is considerable even for a very low profile scale!

To suppress all these influences HAENNI provides specially designed levelling mats of exactly the same height as the scale. They are used to level out the non weighed wheels of a multi axle system. Detailed information is provided in the manuals of the scales, in P 1196 and in P 1216.

Another possibility to avoid all above mentioned problems is to mill a groove in the pavement of the measuring site, which has a depth corresponding exactly with the height of the scale. This solution is called a semi fix installation.

6 HAENNI in the world-wide market

6.1 HAENNI The Position In The Market

HAENNI is the leading company for low profile scales with the models WL 101 and WL 103. HAENNI was the first company, which developed and introduced a low profile scale. Therefore it is the company with the longest experience in design and operation of portable wheel load scales. About 25'000 units have been sold to date.

6.2 HAENNI Sales and Distribution

Since 1975 HAENNI is producing Wheel load scales. The distribution is world-wide, in co-operation with governments and in many cases also with the World Bank. They are in use in more than 100 countries.

HAENNI participates actively in projects of the IDB (Inter-American Development Bank), the EBRD (European Bank of Reconstruction and Development), the ADB (Asian Development Bank) and of the World Bank.

6.3 HAENNI After Sales Service

HAENNI scales are serviced and repaired in our facilities in Switzerland or by our representatives, who are trained by our technical staff.

For HAENNI after sales service is not a big word, but lived practice! Wherever questions around wheel load scales arise, HAENNI is pleased to give assistance and to share its experience!