Sonderdruck – Reprint

from: MPT International Metallurgical Plant and Technology, Issue 6, November 2006

Advanced in-process weighing systems for steel production: accurate and reliable by maintenance-free design

we make processes work

Introduction

This article provides to production and maintenance departments of steel plants and to plant designers an overview over advanced weighing systems, used for example for liquid steel or scrap weighing, that offer high accuracy and reliability combined with crucially reduced time and money effort for maintenance.
Considering the trend of down-sizing maintenance departments going on in parallel with the steadily increasing requirements on productivity, all design improvements, that reduce maintenance on weighing systems, contain a high economical potential. Over the last years the following mechanical features have been developed and successfully executed especially for the various in-process weighing applications:

- design of special strain gauge Load cells,
- definition of best suited installation places for the weighing mechanics,
- continuous exploitation of field experience with installed systems worldwide as technical reference.

The totality of these elements contribute to the fact, that modern in-process weighing systems operate extremely accurate and reliable in the harsh environment of steel production, that is characterised by huge dynamic forces, high temperatures, significant contamination by dust and spillages as well as extremely restricted maintenance and repair access.

The tasks of in-process weighing systems

More than ever before today's worldwide consolidation of steel industry is followed by the constant need for process improvement. Weighing systems have always largely contributed to economical and safe steel production: from the mass control and dosing of raw materials over the processing of hot metal and steel to the sale of finished products. Especially the in-process weighing systems, used for the internal control in the production area (scrap yard, Blast Furnace, Converter, EAF and Continuous Casting Machine) have to operate in an extremely harsh environment. With loads to be weight between 1 and 1,000t, these kind of scales should be mechanically designed for every particular use, leading frequently to solutions very different from conventional legal-for-trade scales like truck or platform scales.
In-process weighing systems generally are used for the following functions of the steel plant management:

- production control for stable quality parameters,
- determination and optimisation of the Yield inside one production unit,
- internal plant mass balancing, "invoicing" of services and production turnover between different production units.

Additional to these control functions reliable weighing systems contribute significantly to increase safety and profitability of the daily steel making process.

Safety:

Where large amounts of liquid hot metal and steel have to be transported between different processing areas, weighing equipment has an essential, safety-critical function in order to avoid spillages and accidents, for example during the weight-controlled filling of ladles. Only weighing systems that operate without any contact to the dangerous products can guarantee the necessary process safety.

Profitability:

Precise weighing systems crucially improve the profitability, allowing to feed the minimum of raw materials and alloys to achieve the desired steel quality respecting the chemical tolerances. An easy calculation example may demonstrate the huge benefit: an annual production of 1 Mio t alloyed steel should contain a final Molybdenum content of minimum 0.45%. The net steel mass as reference for the alloy calculation may be weight in a ladle transfer car or the overhead transport crane scale. Assuming that this scale first operates inside the unsatisfying error limits ± 1% of Full Scale, please find the calculation of the required annual Molybdenum mass:

Correct weight 1: Wc1 =1,000,000 t
Displayed weight 1: Wd1 = 990,000 t – 1,010,000 t

In order to guarantee the final alloy percentage in the melt the calculation of the alloy mass must refer to the maximum displayed weight:

Required alloy mass 1:
Ma1 = 0.45% * 1,010,000 t/a = 4,545 t/a

Improving the weighing system performance to respect error limits ± 0.2% of Full Scale leads to the following result:

Correct weight 2: Wc2 = 1,000,000 t
Displayed weight 2: Wd2 = 998,000 t – 1,002,000 t
Required alloy mass 2:
Ma2 = 0.45% * 1,002,000 t/a = 4,509 t/a

The difference of 36 t Molybdenum (Ma1 – Ma2) represents an annual saving of about 1.5 Mio EUR. It is self-evident, that taking into account all different alloying elements multiplies that benefit. This simple example confirms convincingly, that precise and stable operating weighing systems are an efficient tool to increase the profitability of steel production. Additionally, availability of information about the

exact weight of materials is essential for gaining a better understanding and control of material balances, for example in order to identify and utilise improvement potentials: in the rolling mill a certain amount of material loss is inherent in the process between the annealing furnace and the finished, coiled-up bundle, resulting from de-scaling, cropping and other operations. These mass losses can be totalised over an extended time period and used as data base to optimise the efficiency of the production process. Another example for this approach to improve profitability by detailed weight information and analyse is the tracing and balancing of liquid steel from the converter over the ladle furnace to the beginning and the end of casting in the CCM. Weighing data also contribute to profitability in an indirect manor: the survey of the decreasing tare weight of all steel ladles caused by consumed refractories nowadays is an important input to optimise their repair intervals. In a similar way the load totalising memory implemented in modern crane scale electronics exactly mirrors the crane charging history and directly determines the allowed remaining operation time until the next crane maintenance. These examples demonstrate, than investing in weighing systems leads to a remarkable increase of profitability, easy to calculate in hard figures, that will pay-off in very short time periods.

Requirements for in-process scales

Difficult installation surroundings, for example in ladle transfer cars, ladle transport cranes or under huge scrap buckets mean, that very often the only externally visible part of an in-process scale is the large display. To achieve high mechanical stability of such heavy loaded weighing systems, the weighing mechanics is the key to success: depending on the specific application a suited combination of sensor choice and installation place is essential. The following requirements have to be considered for a proper design and dimensioning of in-process scales for steel production:

Forces

- high forces in the vertical measuring direction from 1 to 1,000 t,
- additional – often unknown – dynamic forces in the vertical measuring direction frequently inherent in the process,
- high lift-off forces opposite to the vertical measuring direction,
- high disturbing forces in both horizontal directions.

Temperatures

- weighing systems in the liquid sector and at the input of the hot rolling mill are exposed to high thermal loading up to 200 °C already under normal operating conditions,
- extreme temperature peaks occur during process accidents.

Contamination

- dust, dirt and slag deposits over the entire mechanical structure.

Operation

- difficult access to the mechanical components of the weighing system,
- ongoing production dictates minimum time windows for maintenance, inspection and repair.

Maintenance aspects

Unlike weighing systems requiring trade use certification, for in-process scales no prescribed maintenance intervals exist. Therefore significant cost savings can be achieved, if special attention is given to optimum maintenance properties. This applies especially taking into account the operational conditions significantly more severe compared to legal-for-trade scales. In-process weighing systems should work virtually maintenance-free for many years under the harsh conditions of use. As one customer once stated: the best weighing system is one, where you don't even know, how it is realised internally! Even if in-process scales do not need do be periodically re-certified, according to DIN ISO 9001 regulations they are part of the plants Quality Management System. This use requires regular check and documentation of proper function and accuracy. For advanced solutions such controls generally are limited to a simple check weighing with a reference weight, confirming quickly the proper function of the weighing system and saving time for both maintenance and production specialists. Regarding in-process weighing systems for steel production a special focus has to be laid on the minimisation of maintenance features for the following reasons:

- in-process scales are installed in places with very difficult access,
- 24 hour production reduces the time windows for any maintenance and control work to a minimum, and
- ongoing reduction of service departments staff today asks for minimised maintenance requirements.

Under these specific conditions conventional weighing solutions often do not fulfil requirements with regard to accuracy, reliability and ease of maintenance sufficiently due to the following problems experienced in practice:

- mechanical destruction of Loadcells by overloading in the measuring direction,
- weighing errors or destruction of Loadcells resulting from missing or no more functional mounting elements, damaged by excessive horizontal loads,

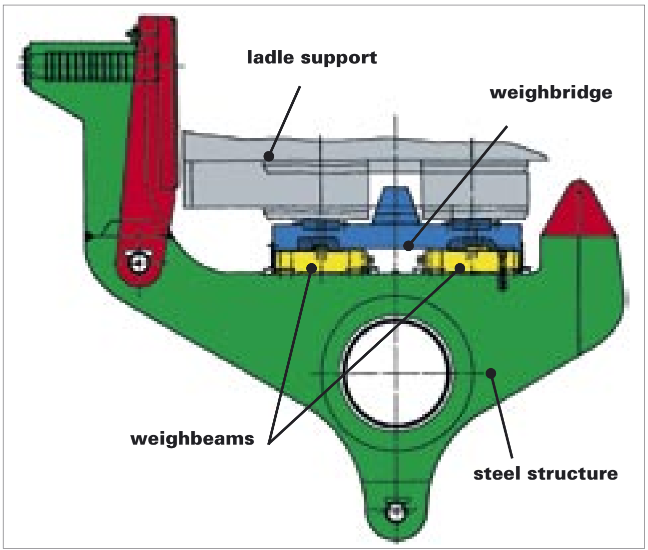

Fig. 1: Basic structure of a ladle turret scale

Fig. 2: Weighing unit of a 350t ladle turret (Courtesy: Siemens VAI)

- overheating of Loadcells and connection cables,
- weighing errors resulting from shunt forces on mounting elements such as tie-rods, bumpers and hold-downs, caused for example by the heat expansion of metallic structures,
- sensitivity to slight changes of the stiffness of the steel/concrete foundation.

Improper working scales not only cause high costs for frequent calibration, control and mechanical checking. Moreover processing improper weighing data affects the efficiency and control of the total production as well as the target quality. The fundamentally different operating conditions in mind, Schenck Process started already in 1985 to develop special strain gauge based Loadcells and applications, the so called Direct Weighing Technologies, optimally suited to design advanced in-process scales for steel industry. It is the main issue of this article to demonstrate, that Direct Weighing Technologies reduce maintenance effort crucially and at the same time improve reliability and accuracy. In order to achieve that technological progress the following main features characterise Schenck Process Direct Weighing solutions:

- easy and simple integration of the weighing sensors inside existing mechanical structures with a minimum number of mechanical parts,
- minimised headroom requirement,
- high static and dynamic load transmitting capability in all directions,
- increased temperature operating range,
- error limit ± 0.1% of Full Scale,
- high repeatability, functional reliability and availability,
- maximum insensitivity against dust and slag contamination,
- special design focus on long-term maintenance matters.

Advanced in-process weighing systems offer to the steel plant an increased production availability by minimised shutdown intervals for regular or emergency maintenance. Especially the mechanically optimal adapted solution is the key to success. Industrial experience with various successfully executed installations worldwide has proven, that state of the art in-process weighing systems represent an excellent investment, justified by increasing confidence in accuracy and reliability of weighing data and significant reduction of maintenance costs.
In the next chapter we like to present some typical application examples of advanced in-process weighing systems, offering a high degree of accuracy and availability achieved with minimum maintenance intervals. Many of these solutions are used as weighing standard for new plants by the international steel plant main contractors.

Examples of advanced mechanical solutions for in-process scales

To meet the above requirements the following design elements have to be optimised together:

- design and selection of the best suited sensors for each application,
- selection of optimum installation place, and
- design of the load application structure.

Example 1: Ladle transfer car and ladle turret scales

Ladle transfer cars are used for the transport, ladle turrets for casting of liquid steel. The ambient environment of the weighing systems is characterised by:

- high mechanical impacts during the positioning of the ladle support on the weighbridge,

- elevated temperatures due to radiation heat and heat conduction from the liquid hot metal or steel
- mechanical movement in operation with the permanent risk of cable damages,
- high contamination, particularly for ladle transfer cars (splashing slag during tapping and the secondary metallurgy).

Figures 1 and 2 show the mechanical integration of a weighing system inside a ladle turret: two Weighbeams DWB (figure 3) are screwed below each ladle support. Specific load directing plates adapted to the geometry of the ladle allow the transmission of all dynamic loads during positioning. Weighbridge (blue colour in figure 1) and steel structure (green) are only in contact with each other through the sensors. No additional bumpers, tie-rods or hold-downs exist. Concerning maintenance matters the extremely small dimension of that weighing arrangement reduces the risk of shunt forces under contamination to a minimum. Besides temperature heating of the weighing equipment is limited, because the huge ladle suspension plates provide protection from heat radiation. It is a further advantage, that, if necessary, the installation place of the weighing system allows rather easy access and repair. The Weighbeams of the DWB type are the key components of the Schenck Process Direct Weighing Technologies. Additionally to the benefits resulting from the suited installation place they represent with their own technological features the second main design element for high accuracy and reliability by minimised maintenance:

- simple fixed bolting between the weighing and the non-weighing structure, resulting in an eliminated risk of shunt forces,
- no mechanical adjustment,
- minimum number of installed parts,
- no moving parts, hence no wear,
- simple design and assembly,
- operating temperature range up to 150 °C,
- free of electrical destruction up to peak temperatures of 180 °C,
- special connector to avoid cable damages.

To further increase operational availability, each Weighbeam is equipped with an integral temperature sensor, enabling the temperature inside to be monitored at any time in the control room. This makes sense as preventive maintenance function in order to protect the Weighbeams from thermal damages caused by increasing temperatures at an early stage of time, for example by activating an additional air-cooling in critical situations. Each of these design elements contributes essentially towards ensuring high weighing accuracy, respecting the error limits ± 0.1% of Full Scale, guaranteed over long terms especially by the maintenance-free design.

Ladle transport crane scales

For the transport of liquid hot metal and steel in ladles weighing up to 600 t ladle transfer cars and overhead cranes work together. Whether the integration of a weighing system inside the transfer car or the transport crane is the best solution in general terms cannot be stated, because it depends essentially on the process logistics and the possibilities to implement the required mechanical modifications. If the decision has been taken to integrate a weighing system inside the ladle transport crane, the following principle installation places can be considered:

- weighing inside the crane trolley, or
- weighing inside of the spreader beam/crane hook.

Experience with many ladle transport crane scales has proven, that from the maintenance point of view considered in this article weighing solutions integrated in the crane trolley offer a higher degree of safety and should therefore be preferred to spreader beam solutions for the following reasons:

- easier mechanical integration inside existing structures, so no need to manufacture a new spreader beam,
- unlike in the case of weighing systems integrated in the spreader beam there is no vertically moving energy and signal cable, which is always prone to failure by heat or mechanical destruction,
- the elasticity of the crane ropes significantly reduces dynamic loads,
- the big vertical distance from the ladle significantly reduces thermal loads.

The three main mechanical installation areas for weighing systems inside the trolley of large ladle transport cranes are illustrated in figure 4.

Fig. 3: Schenck Process Weighbeam DWB

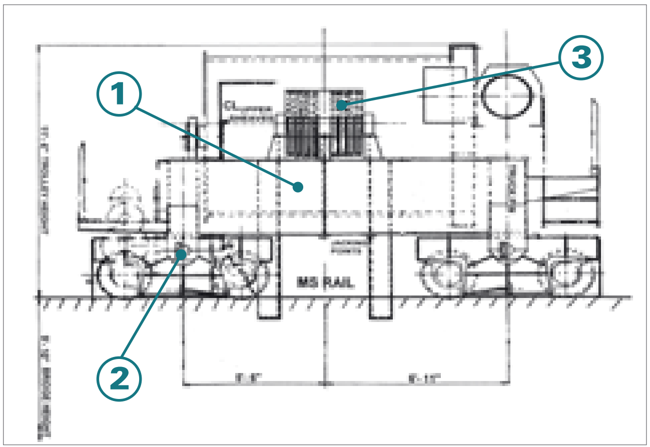

Fig. 4: Installation places for a weighing system inside the trolley of a ladle transport crane
1) total weighing of the crane trolley with a double frame,
2) total weighing of the trolley in the area of the wheelbase,
3) partial weighing of the upper sheave block.

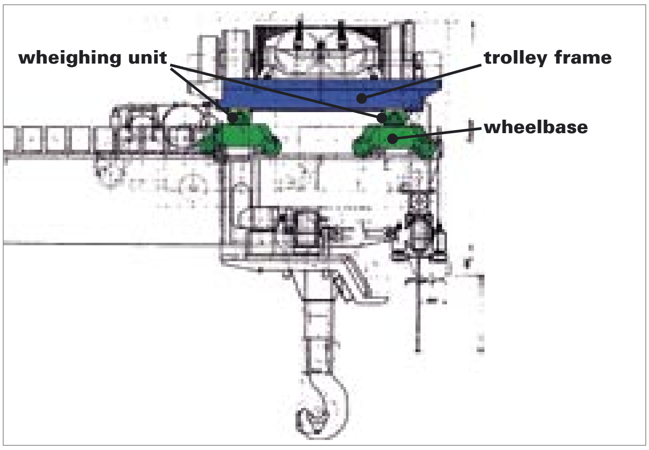

Fig. 5: Basic structure of weighing in the area of the wheelbase (Courtesy: Arcelor Gent (SIDMAR))

As the available headroom for existing cranes usually rules out the option of weighing the entire crane trolley by means of a double frame, only the solutions 2) and 3) will be outlined below.

Example 2: Weighing of the crane trolley in the area of the wheelbase

The design principle of this solution consists of the integration of several weighing units at the mechanical interface between trolley frame and wheelbase, in order to measure the total weight of the ladle transmitted over this section. It is self-evident, that this solution has to be capable to transmit all horizontal and vertical forces applied during normal crane operation. Each weighing unit consists internally of several Weighbeams DWB as presented before. The low required headroom of 220 mm, visible in figures 5 and 6, makes the solution extremely suitable for revamping existing crane trolleys. On the other hand, seen the huge vertical space and the investment for a heavy double weighing frame, its not surprising, that the wheelbase design is more and more also selected for new ladle transport crane weighing systems.
The main advantages of the wheelbase weighing concept in terms of accuracy, reliability and ease of maintenance are:

- maintenance-free installation through completely bolted weighing units,
- the existing mechanical connections/screw fixations of the crane structure are used with out any modification for the fixation of the weighing units,
- no moving parts, no adjustment or wear,
- no critical cable connections,
- the weighing system can easily be protected from heat radiation due to its compact and modular design.

Ladle transport crane scales designed according to this principle usually respect error limits ± 0.1 % of Full Scale.

Example 3: Weighing at the crane trolley inside the upper sheave block

The variety of crane executions forces designers of weighing equipment to keep an open eye for several possible variants at all times, finally finding a suitable solution concerning accuracy, costs of equipment and installation, downtime necessary for the weighing modification, installation height and maintenance properties. During the design of weighing systems for those heavy ladle transport cranes especially the required time for modification and maintenance has to be taken into account, as these cranes usually operate around the clock and minimum maintenance shifts will leave virtually no time for works on weighing equipment for months. The second application example for a crane weighing systems often is suited in cases, where weighing equipment at the wheelbase cannot be realised for reasons of mechanical adaptation. Figures 7 and 8 show as alternative solution a very simple weighing installation inside the main hoist upper sheave block supporting plates.

The approach used for this weighing system is based on force sensors developed specifically for this application, the so-called Radial Force Sensor DRA (figure 9), installed inside the vertical supporting plates of the upper sheave blocks. These sensors measure and transmit radial loads applied by the crane cables, in this execution directly converting the supporting plates to a part of the weighing system according to the Direct Weighing Technology principle. Main features and design advantages of this solution are:

- no modification of the crane static's,
- no modification of the main axle diameter and the sheaves used by the customer,
- no additional headroom,

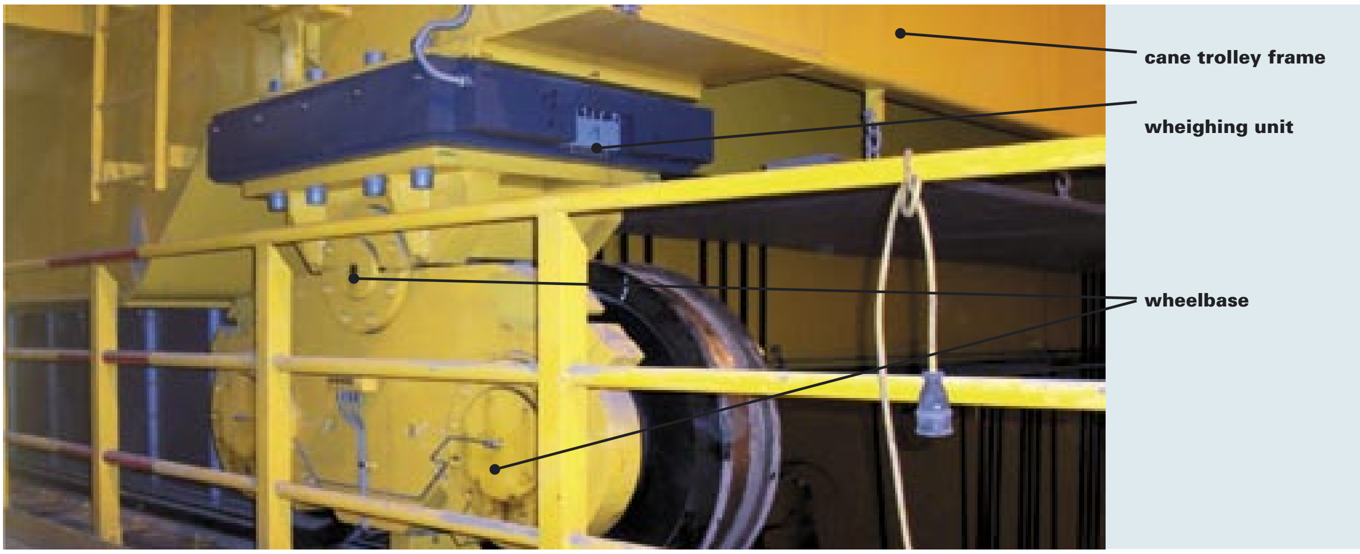

Fig. 6: Weighing unit of a 400 t ladle transport crane (Courtesy: Siemens VAI)

- extremely easy and fast retrofit: pre-assembly of the DRA sensors inside a new sheave block in the workshop, followed by welding this block onto the crane trolley steel frame.

With a view to the positive maintenance properties, this solution is essentially equivalent to weighing equipment installed in the area of the wheelbase particularly concerning the uncritical cable ways. Considering access to the mechanical structure and temperature protection, it has to be judged even superior. Upper sheave block weighing systems measure up to 90 % of the ladle weight through the crane cable forces. To compensate the height depending effects of the non-weight cables to the cable drum, advanced weighing electronics provide a cable length compensation, enabling those scales to respect the error limits ± 0.2 % of Full Scale.

Example 4: Scrap yard scales

Next to the steel works, scrap yards are another major application area with specific demands on in-process weighing equipment. Although thermal loading does not play a particularly important role in this part of the plant, high mechanical loads occur during charging of scrap for the converter or the EAF: frequently, the impact of a single block of scrap with a weight of 5t dropping from a height of 5 m inside the unloaded basket must pass the weighing system safely. Other important conditions for weighing systems used for scrap charging are:

- during cleaning the weighing platform from scrap residues with the electromagnet, strong lift-off forces are applied on steel weighbridges,
- undamped dropping of scrap pieces will frequently also cause additional horizontal loads.

In the past, scrap weighing systems frequently were designed as raising platform scales, taking into account these difficult operational conditions: during dynamic loading the Loadcells were taken out of operation and therefore protected from excessive loads. Only at the expected end of the loading process a hydraulic system directed the weight over the Loadcells to the ground, so that the scrap mass charged up to this moment could be displayed. This solution contained the following fundamental disadvantages:

- no information about the weight already loaded during the charging process,
- difficult procedure to arrive at the desired set point,
- the entire hydraulic and control system requires significant maintenance,
- during normal production the mechanics and hydraulics in the concrete foundation are not accessible for control and maintenance,
- loss of time.

As this example shows, scrap yards require special weighing solutions ensuring highly accurate and low maintenance operation. Technical progress achieved over the last years

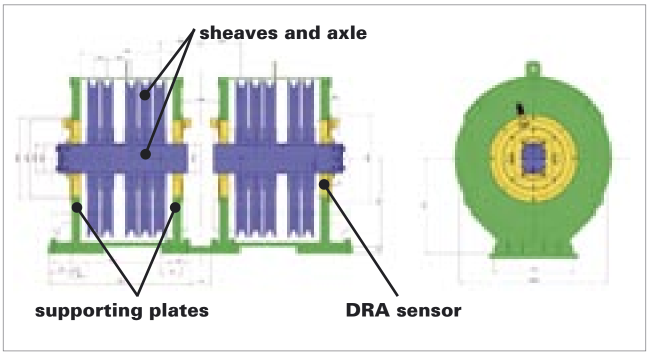

Fig. 7: Basic structure of an upper sheave block weighing system


Fig. 8: New upper sheave block 350 t with pre-assembled DRA-sensors (Courtesy: Ternium Sidor), Fig. 9: Schenck Process Radial Force Sensor DRA

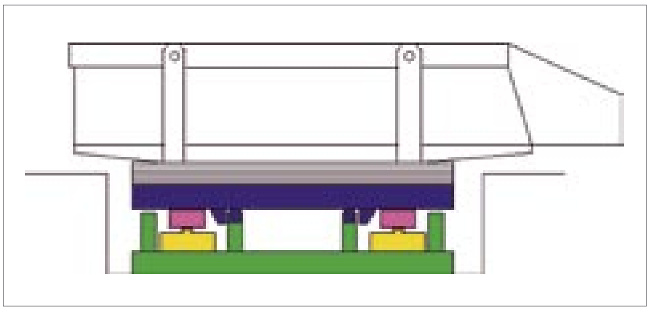

Fig. 10: Basic structure of a platform scale for scrap loading

has provided such solutions. Basically, four possible installation places can be distinguished for weighing systems used on the scrap yard, depending on the underlying logistical concept:

- stationary on-floor mounted platform scales installed in a roofed scrap building, on which scrap buckets are positioned with the help of the huge scrap transport crane,
- stationary in-pit platform scales for outdoor installation, on which scrap buckets, chutes, trailers or wagons are positioned for charging and weighing,
- mobile scales integrated inside scrap transfer cars, trailers or carrier racks, and
- crane scales integrated inside the small scrap charging cranes.

Each of these places has its own advantages and inconvenients, so that the best weighing solution can only be determined by carefully analysing the exact conditions at site. Essential criteria with regard to design, maintenance and accuracy are:

Platform scale in the scrap hall:
best solution, but requiring heavy investment.
Outdoor platform scale:
risk of weighing errors and high maintenance effort due to blocking of the platform gap with small scrap parts and high contamination of the foundation pit by dirt.
Mobile weighing systems:
reduced risk of shunt forces due to the installation place of the weighing components above floor, but need of additional elements for power supply and data transmission. Besides additional headroom is needed.
Loading crane scales:
normally difficult to retrofit due to the cost and time effort connected with the modification. Significant weighing errors arise from the fact, that parts of the scrap weighed while hanging on the crane do not drop into the basket.

The following example shows a solution, that has been found to work properly both as in-pit platform and mobile scale:

Figures 10 and 11 show a simple design for a heavy scrap weighbridge 5 x 5 m based on Schenck Process Weighbeams. Also in this case the weighbridge is completely screwed onto the Weighbeams, ensuring that the weight of the scrap is accurately determined and displayed at all times of the loading process. Hydraulic equipment no longer is required and the simple execution without any tie-rods means, that the mechanical equipment works maintenance-free. The overall concept of this special platform scale includes the following additional elements to optimise the availability:

- high overload capability up to several times the Weighbeam nominal capacity, ensuring that the system will transmit even extreme impact loads without suffering damages,
- high permissible horizontal deflection of the weighbridge, resulting in a self cleaning effect of the weighbridge gap during operation.

As this example demonstrates, Direct Weighing Technologies allow integral weighing solutions, that provide the design features customers expect from advanced scrap yard weighing systems:

- total error limits ± 0.1 % of Full Scale,
- charging accuracy for scrap up to ±1 % of the net mass,
- uncritical transmission of impacts into the foundation,
- minimum inspection and maintenance requirements.

This last example completes the presentation of some mechanical weighing solutions conceived specifically for in-process weighing systems of steel industry. All solutions, consisting of sensors and surrounding mechanical arrangements, have been developed through longstanding, close cooperation between Schenck Process and its partners in steel industry. Various other applications have been optimised concerning the weighing performances in a similar manor using Direct Weighing Technologies: examples are torpedo railway scales or top hopper scales of Blast Furnaces.

Fig. 11: Scrap platform scale 130 t with Schenck Process Weighbeams DWB (Courtesy: ThyssenKrupp Nirosta)

As a comparison: conventional solutions for industrial weighing systems requiring legal-for-trade certification

The huge variety of weighing applications in steel plants has to be distinguished in legal-for-trade and in-process systems: legal-for-trade scales usually are located at the beginning of the production process for the purchase of raw materials and end for the sale of coils, bundles or finished sections. In these areas the ambient conditions for the installation of weighing systems do not pose major problems for the so-called conventional weighing solutions. They are designed as hopper scales, road weighbridges and crane or roller table scales with a weighing range between 1 and 100 t. The weight is transmitted through a bridge structure and several legal-for-trade approved Loadcells with appropriate mounting elements (figure 12 and 13) to the ground. The installation example in figure 14 shows a typical coil scale with a weighing range of 35 t and a legal-for-trade increment of 10 kg, executed with 4 Loadcells RTN 33 t C5. This conventional solution for the weighing mechanics, based on Loadcells, Elastomer Mounts and external bumpers has proven to work extremely reliable in steel plants worldwide. It is cost-efficient, very accurate and requires only a minimum of maintenance. As all legal-for-trade scales need periodic re-certification at any rate, this will ensure that the operating status of the weighing system is routinely checked at regular intervals.

This simple example of a legal-for-trade coil scale is suited to point out the importance of a maintenance optimised design of industrial weighing systems: figure 15 shows one of the four supporting points of this scale, characterised especially by the distant arranged bumpers with a nominal clearance of 2 mm between the weighing (in blue) and the non-weighing (in green) bumper supports. If horizontal loads are applied on the weighbridge, for example during the positioning of the coil, after a horizontal deflection of the weighbridge of 2 mm these bumpers transmit all further horizontal forces directly to the foundation, thereby protecting Loadcells and Elastomer Mounts from damages.

The main advantage of this bumper arrangement in comparison to a tie-rod solution shown in figure 16 and used for the same purpose is the fact, that the clearance of the bumpers can be checked and if necessary adjusted at any time very easily. As long as this clearance is free, the 100 % load transmission over the Loadcells during static weighing is guaranteed. It's especially that clear statement, that makes maintenance so easy for bumper solutions and – on the other hand – often so difficult for tie-rod solutions. Tie-rods always represent a small, unfortunately unknown and invisible shunt force influence on the weighing accuracy, that is subjected to change during the years of the scale operation. This simply example already points out the consequences of a different mechanical scale design regarding especially maintenance matters. Industrial practice has shown moreover, that it makes special sense to distinguish

Fig. 12: Schenck Process Loadcells RTN, Fig. 13: Schenck Process Elastomer Mount VEN

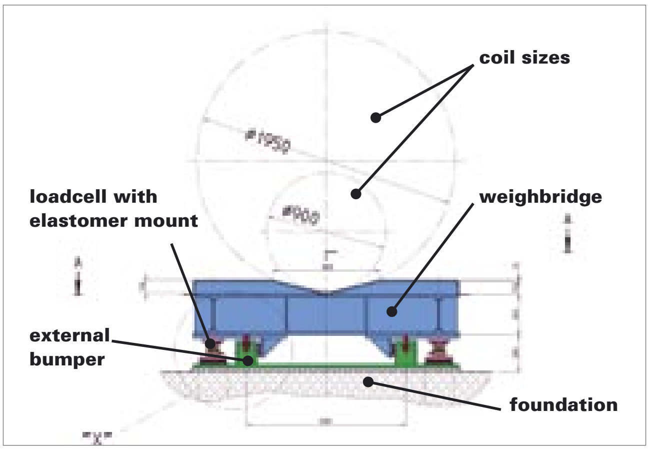

Fig. 14: Basic structure of a legal-for-trade coil scale 35 t

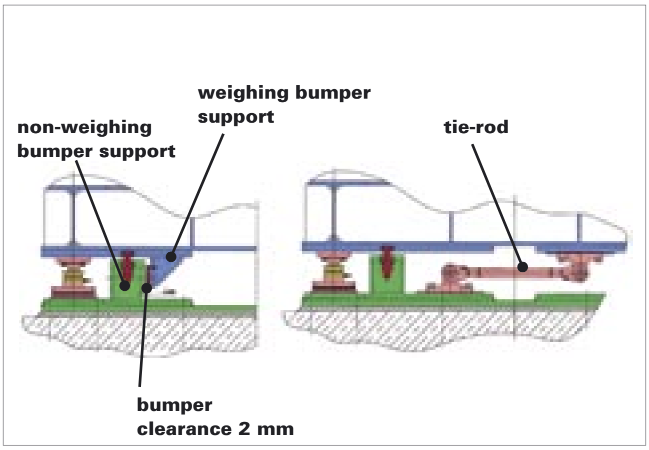

Fig. 15: Bumpers for horizontal load transmission, Fig. 16: Tie-rods for horizontal load transmission

the in-process weighing systems from the legal-for-trade systems presented above concerning maintenance matters. A principal argument for this approach is the fact, that in-process weighing systems have to work under entirely different operational conditions, as listed in the previous chapters.
The next chapter describes a number of features of advanced weighing electronics, that also contribute essentially towards increasing the functional reliability and availability of weighing systems and that enable preventive maintenance.

Last but not least:
features of modern weighing electronics

Additionally to the modern mechanical solutions today's weighing electronics also contribute to increase operational reliability and reduce maintenance of in-process scales. The primary task of the weighing electronics is to filter and convert the analogue signals in the range of only a few Millivolts from the sensors to a stable digital signal. Due to the specific ambient conditions for in-process scales the Direct Weighing Loadcells still today are designed as analogue and not as digital Loadcells. Nevertheless the advantages of digitalisation are available inside Schenck Process scales as well.
As a first example for advanced weighing electronics figure 17 shows the DISOBOX®. Installed in a field housing it is designed for an installation close to the weighing mechanics. Inside the DISOBOX® every single Loadcell input signal is digitized and transformed into weight values by up to 8 independent A/D converters. The total weight is calculated based on these individual weights by simple software addition. The output cable transmits the single weights and the total weight directly to the customer control system by serial interface. The major advantage of this weighing electronics is the fact, that the weight measured by every single Loadcell is available in the control room at any time. This enables maintenance staff to detect assumed sensor performance deterioration, for example caused by cable damages, and to switch off this Loadcell electronically without costly and time-consuming intervention outside in the field, until repair or exchange is possible. Over and above this possibility of a manual intervention, the DISOBOX® also features automatic monitoring functions such as continuous zero signal checking, allowing to recognise automatically gradual growing errors for example caused by increasing shunt forces at a very early stage of time. By an automatically generated warning in case of discrepancies that self-check of every single Loadcell increases the operational reliability and accuracy of the weighing system significantly. Also, early recognition of potential future problems reduces the total maintenance effort and the risk of sudden failures with the associated serious impacts on production and control.

Different to the DISOBOX® the DISOMAT® B plus (figure 18) has been designed as a Weighing Terminal for applications with data exchanges by a scale operator for example in a crane cabin, requiring display and push buttons. Considering specifically maintenance aspect, first the integrated load totalising memory module enables the crane maintenance staff to receive an accurate report about the

Fig. 17: Schenck Process DISOBOX®, Fig. 18: Schenck Process DISOMAT® B plus

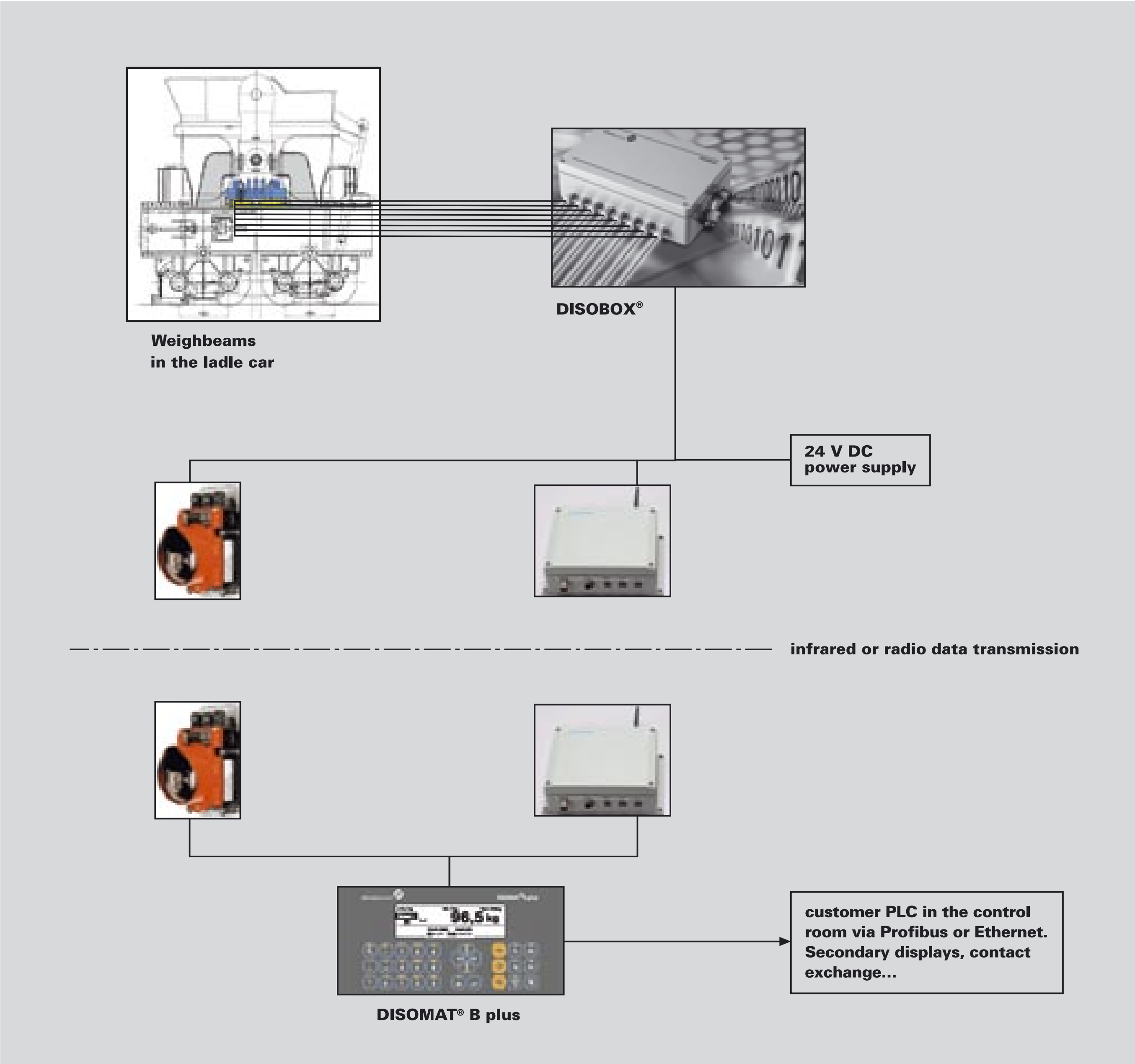

Figure 19. Application example for a ladle transfer car weighing electronics

total mechanical load cycles applied on the crane mechanics over a defined period of time, allowing optimally expanded maintenance intervals depending on the varying loading conditions. A second major contribution in terms of ease of maintenance is made available by the DISOMAT® B plus advanced communication capabilities, for example through the Ethernet interface. In Web Server operation all essential data of the weighing system can be displayed by means of an Internet Browser, simply by selecting the associated IP address. Given the appropriate authorisation weighing data can be viewed throughout a company's Intranet or even from outside through the Internet. This will provide to the maintenance workshop in charge of the weighing systems quick and easy information concerning the proper function of the most important in-process scales. Figure 19 visualises as typical in-process weighing application a modern ladle transfer car electronics. The combination of the DISOBOX® located in the field and the DISOMAT® B plus installed in the control room represents the maximum degree of preventive maintenance optimisation due to the following features:

- single sensor weight monitoring in the control room,
- emergency mode operation and calibration from the control room,
- wireless data transmission between the field and the control room, hence no endangered cable connection,
- safe digital data transmission.

www.ko-kom.de

Conclusion

At the end of the presentation of some advanced solutions for in-process weighing systems we hope having been able to demonstrate, that especially for these kind of scales a higher effort in the mechanical and the electrical design in order to achieve largely accurate, reliable and highly maintenance-reduced weighing systems is more than justified by the increase of confidence in the scale performances, leading for the instrumentation or maintenance department to

- a minimisation of maintenance and control time effort,
- an expansion of maintenance and control intervals, and
- minimised trouble-shooting and analyse actions.

The production department also benefits from those highly maintenance-reduced scales by an increased accuracy, reliability and availability of the scales for their original purposes in the process control. Confidence in weighing systems means, that the correct operation condition is confirmed by a proper and mechanically stable design over long times of operation, leading to minimised time and material effort for checking and re-calibration. Schenck Process in-process scales usually are only checked in time intervals of 3-6 month in the following simple manor:

- visual control of the surrounding of the scale mechanics,
- control of an eventual change of the offset signal stored inside the weighing electronics,
- one check-weighing with a test weight as confirmation of the still correct calibration.

A further benefit of maintenance-free scales is the reduced need for spare parts, as Direct Weighing solutions are not subjected to any mechanical movement or wear and withstand the normal harsh environmental conditions without any aging.

Especially the close cooperation between steel plant operators, plant designers and weighing specialists has ensured a continuous technological progress for in-process weighing systems within the last years. As system supplier we guarantee for the specified accuracy of the entire weighing system in operation, proven by the optimally suited mechanical and electrical components and our engineering as base for long year proper weighing operation regarding accuracy, reliability and maintenance effort. In-house development, design and production of Direct Weighing Technologies for steel industry enables Schenck Process to meet ever growing customer requirements, assuring to all partners involved a continuous benefit also in future.

Author:
Martin Brauer, Manager Static Weighing Technology,
Schenck Process GmbH, Darmstadt, Germany
heavy@schenckprocess.com

schenck process

Schenck Process GmbH
Marketing Communication
Pallaswiesenstr. 100
64293 Darmstadt, Germany
T +49 61 51-15 31 29 87
F +49 61 51-15 31 27 54
press@schenckprocess.com
www.schenckprocess.com

BV-S 2025 GB