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Title: SUPER-HYBRID-SENSOR FOR NEW BALANCES

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SUPER-HYBRID-SENSOR FOR NEW BALANCES

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ABSTRACT

We developed a new weighing sensor construction which we named Super-Hybrid-Sensor (SHS) for the new GX series electronic balance. The construction of the SHS is a hybrid body which combines an Electromagnetic Force Motor and a Roberval body, the construction of which is same as a Load Cell using strain gauges. Since the SHS has both greater stability, due to its Roberval body, and greater sensitivity, because of the Electromagnetic Force Motor, the new sensor achieved a faster response time of approximately 1 second and higher stability (for example, 2mg by 6000 g) compared to conventional weighing sensors. We report the principle, construction and features of the SHS and also report specifications, performance & benefits of the new GX series electronic balance.

Keywords : Super-Hybrid-Sensor, Sensitivity & stability, Fast response time

1. INTRODUCTION

We developed a new weighing sensor construction named Super-Hybrid-Sensor (SHS).

The SHS construction is a hybrid body that combines the fulcrum and beam used in an electromagnetic force motor type sensor and a Roberval body, the construction of which is the same as a load cell using strain gauges.

SHS has a performance which combines the best benefits of the electromagnetic force motor balance with high resolutions in sensing method and the strain gauge load cell balance with high stability Ronberval construction for an object's loading on the weighing pan.

We now introduce the descriptions of the SHS characteristics and brand-new GX balance series with SHS installed. (See Fig.1~3)

2. SHS CONSTRUCTION & FEATURES

On an electromagnetic force balance, it is relatively possible to realize one/millionths resolution with down to earth footprint dimensions. Therefore, in many fields, the use of high resolution balances has set new records; however, the mechanical loading and sensing sections need to overcome the factors which complicate adjustments and solutions of four-corner errors on the weighing pan.

One of the above-mentioned factors is the large number of parts required for high resolution performance. These parts must be machined and processed precisely, ranging by $1x10^{-6}$m to $10x10^{-6}$m and there is a greater chance of error for assembly due to many parts.

These types of potential problems have caused malfunctions and poor production yield with higher production costs for balances.

To solve them, the SHS is constructed as an all in one type Roberval construction and conventional 60 parts can be reduced to one part. (See Fig.4)

By using SHS, we have realized faster response times brought about by solving assembling errors and greatly cutback on parts and assembling process costs. We also combined the all-in one type Roberval with beam through fulcrum and tension flexures.

By aligning the above components separately, we were able to use conventional mechanical processing machines to produce Roberval, fulcrum and beam components without any problems.

By employing established processing method, we realized that there could be sufficient space between each weighing sensor component, including the Roberval structure.

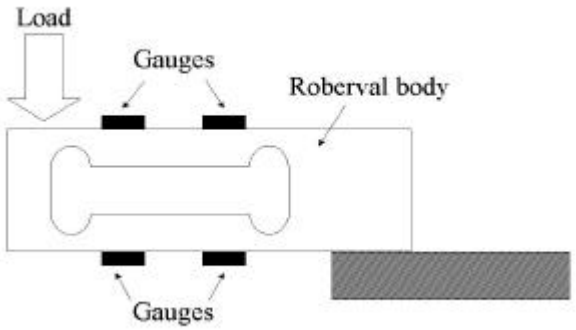

Fig.1 A load cell with strain gauges

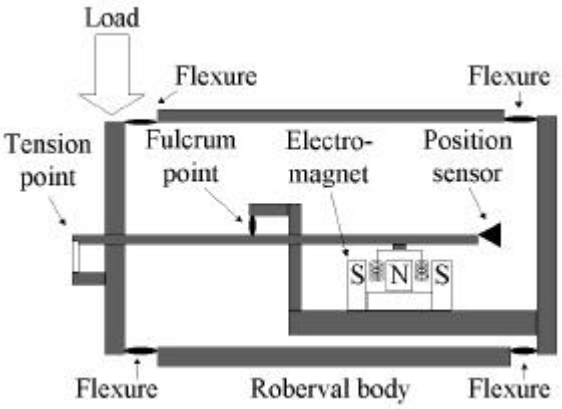

Fig.2 A conventional force balance

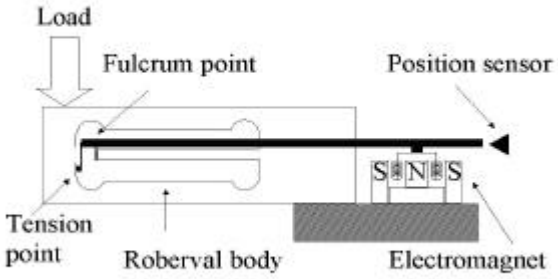

Fig.3 A force balance with SHS

The bottom line is that the construction is very resistant to dust penetration of the balance housing.

Additionally, the fulcrum and tension flexures, which are the main cause of mechanical malfunctions generated by overloading and impact loading, can be easily replaced and maintained.

The SHS features are summed up as follows:

1) High performance
   Through hybridization, Roberval construction is highly stable and provides fast responses & high resolutions.
2) Smaller weighing sensor
   The highly stable Roberval and the reduced number of components allowed us to decrease the size of the weighing sensor section.
3) Reliability
   Construction and housing that is resistant to dust, powder and other fine particulate matter.
4) Reduced production costs
   Reducing the number of and the size of parts, material & assembly resulted in greatly reduced processing costs.
5) Lower operation and maintenance costs
   Fewer parts, such as fulcrum and flexures, need repair so maintenance is very efficient.

3. FEATURES OF GX BALANCE WITH SHS INSTALLED IN

1) As a top loader precision balance, GX with SHS installed in has realized resolutions as high as 1/600,000. The maximum resolution weighing capacity with the minimum display models are as follows: (See Fig.11)

   600g x 0.001g,
   6100g x 0.01g,
   8000g x 0.1g

   GX models have national weight & measure certificate, and also have a certificate class **II** of EC type-approval in Europe.

2) Fast response
   By using SHS technology, GX's response time is very fast and under good environmental conditions, GX weighing reading can stabilize within one second. The all in one type Roberval construction provides high stability which brings an increase in the characteristic frequency of the sensor and flexible design control over the electronics and software and extremely fast response times. (See Fig.6~9)

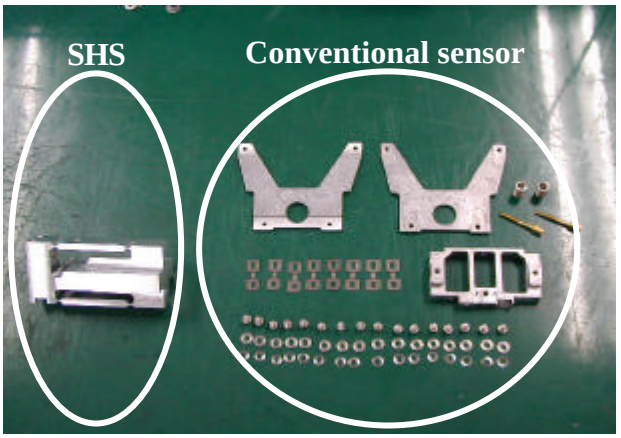

Fig.4 SHS vs. Conventional sensor

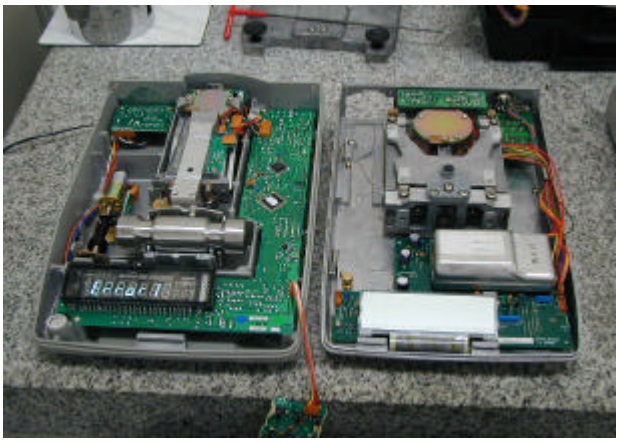
Fig.5 GX with SHS (left) vs. Conventional balance HF

3) Weight reading enhancement

Using the SHS technology, the weight reading was improved.

For instance, on the GX-6100 (6100g x 0.01g), an internal resolution of 0.001g was confirmed, which is the one digit greater than its minimum display of 0.01g. Using the GX-6100g, a 5kg object is weighed using three digits after the decimal point (0.001g), with a resulting internal resolution of 1/5,000,000. (See Fig.10)

4) Small footprint

Using a weighing sensor with SHS technology, the footprint of the sensor unit area was reduced by a 50%. With this downsizing of the sensor unit, the external physical dimensions of the existing top loader precision balance could be maintained and an internal calibration mass could be installed. (See Fig.5)

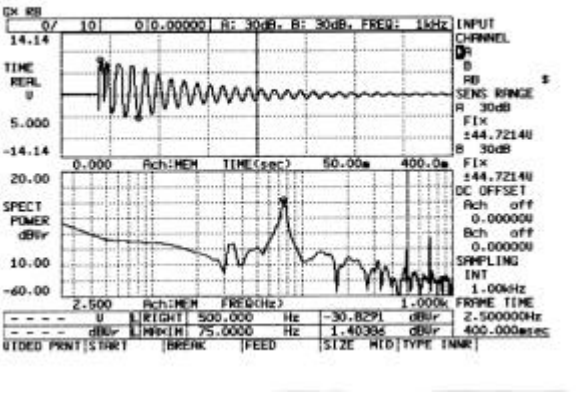
Fig.6 Impulse response for SHS body (peak at 75Hz)

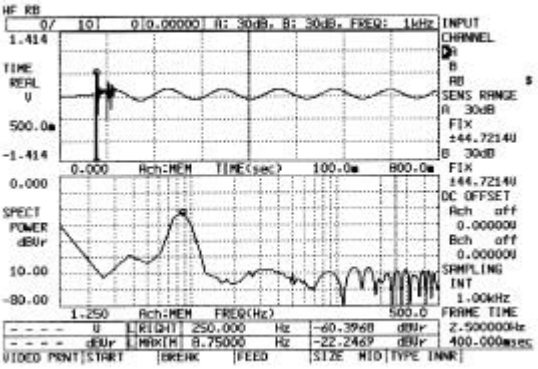
Fig.7 Impulse response for conventional sensor's body (peak at 8.75Hz)

5) Cost savings

By employing the SHS technology, the cost of the weighing sensor unit was reduced by 50 % compared to in-house conventional balances. The cost savings brought our users high performance at more affordable prices. The decrease in the number of parts and materials were reduced, resulting in less industrial waste, which will contribute to environmental protection.

6) GX balance features of special interest

The newly added features and performance are:

a) Automatic Adjustable Environmental Setting:

GX adapts to the most suitable environmental setting automatically with one-touch key operation.

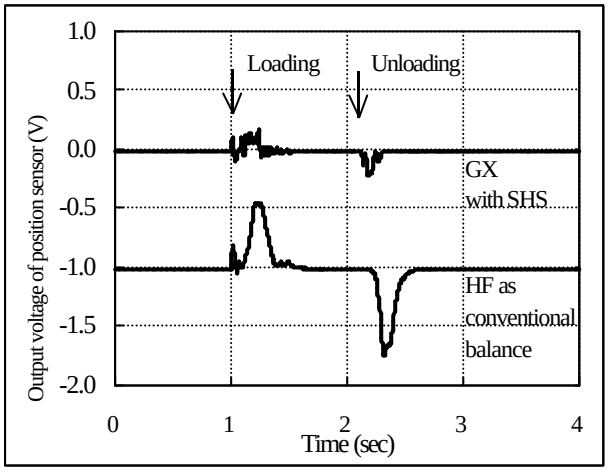

Fig.8 Beam position with response time

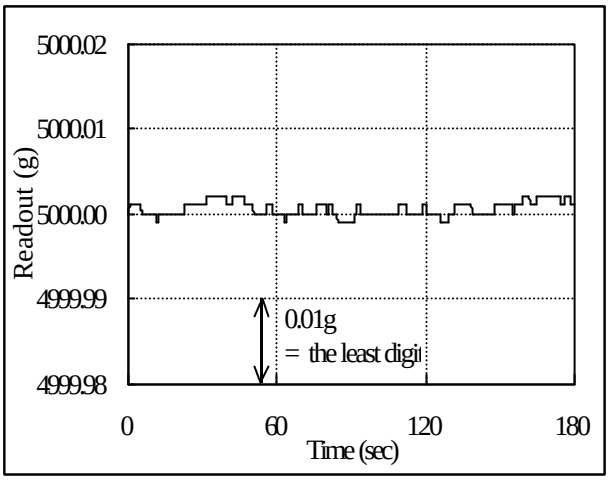

Fig.10 Stability for GX with SHS

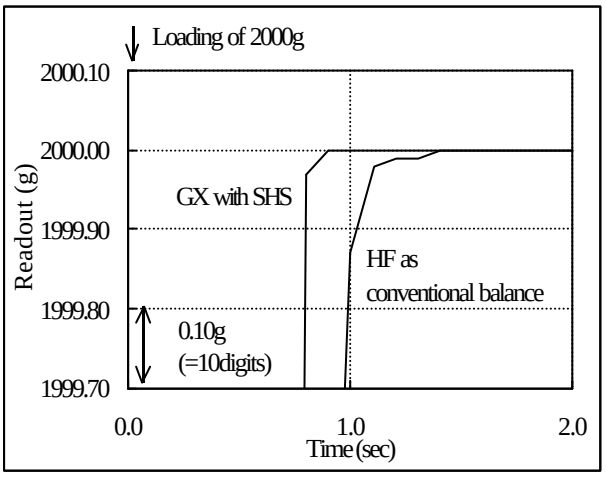

Fig.9 Readout with response time

Fig.11 GX series

In an ideal environment, the fastest response setting can be set automatically and where there are drafts and/or vibration influences, the response setting can be automatically set to middle and/or slow to let stable reading take top priority.

b) Data Memory Function:
Weighed values can be stored in memory.

c) Communication with external devices such as a PC and a printer:
The RS-232C interface and A&D's Windows based PC software, Windows Communication Tools (WinCT) allows the balance to send weighing data to a PC, are standard features.

4. SUMMARY

The SHS achieved a fast response time of 1 second and high stability as a balince.
To date, the SHS has been installed only in the GX Series balances. Plans are currently underway to expand the SHS capabilities, such as an increase in weighing capacity and higher resolution. Additionally, future plans are being considered to produce new products with the SHS's high performance, reliability, smaller size and affordable price into new markets and in existing markets where customers' requirements can not be met using the older conventional electromagnetic force balance technology.