STANDARDIZATION OF THE LEEB HARDNESS TESTING METHOD

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SUMMARY

The instrumented rebound test method invented by Leeb several years ago has been successfully developed into a viable portable hardness test method that is particularly useful for cast materials and steel forgings (see Fig. 1).

Fig. 1: Typical Rebound hardness testing application

A standard covering this test method was published by ASTM in 1996 and revised in 2000. The paper will include a brief technical description of the test method and will discuss the need for conversion from the Leeb Hardness Number to other commonly used hardness scales.

1. THE REBOUND METHOD

Hardness testers using Leeb's method operate in a slightly different manner as compared to standard testing methods like Vickers, Rockwell or Brinell. The hardness is indirectly measured via the loss of energy of a so-called impact body (1).

A mass is accelerated to the surface of the test object and impinges on it at a defined speed, i.e. kinetic energy. The impact creates a plastic deformation of the surface, i.e. an indentation, due to which the impact body loses part of its original speed - or energy. It will lose more speed by creating a bigger indentation and, thus, at softer material. Technically, this principle of measurement is implemented by means of an impact body which has a spherical tungsten carbide tip and which is impelled onto the test surface by spring force. The speeds after and before the impact are each measured in a non-contact mode. This is done by a small permanent magnet within the impact body (Fig. 2) which generates an induction voltage during its passage through a coil, with this voltage being proportional to the speed (Fig. 3).

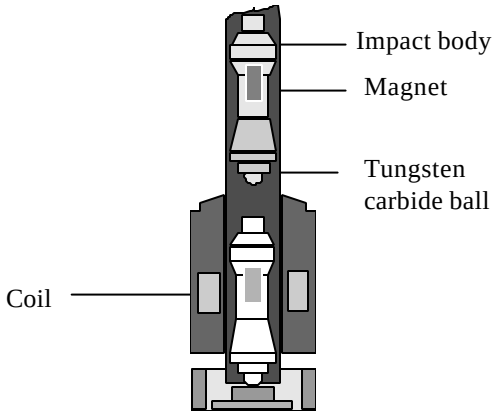

Fig. 2: Cross-cut of a typical impact device

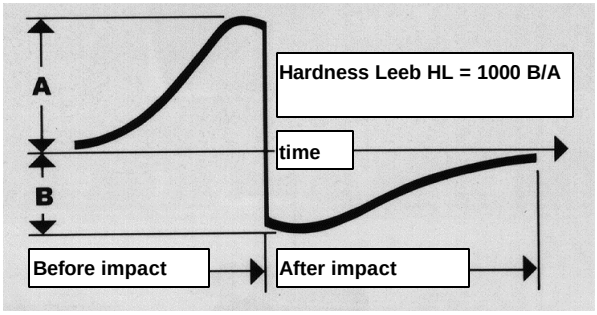

Fig. 3: Voltage signal generated by the impact body penetrating through the coil. The signal is shown before and after the impact

2. LEEB'S SECRET

The Swiss inventor of this method, D. Leeb, defined his own hardness value, the Leeb hardness value. The Leeb hardness value, HL, is calculated from the ratio of the impact and rebound speed.

You might asked yourself: "Who wants to measure the hardness value in Leeb?". The answer is: as a matter of fact, anybody who uses the rebound hardness testing method does it because the Leeb hardness value is, by its definition the actual physical measurement value behind this method. However, only a few users indicate the Leeb hardness value HL in his specifications or test reports. We mostly convert into the required hardness scales (HV, HB, HS, HRC, HRB, N/mm2). For this reason, only conversion brings the rebound hardness method to life.

Velocity measurements according to the Leeb principle are influenced by the Elastic or Young's Modulus of the material under test. That means that

two different materials with the same “real” hardness possibly show different HL values, due to the different Young’s Modulus.

1	Steel
2	Alloy Steel
3	Stainless Steel
4	Grey Iron
5	Nodular Iron
6	Aluminum
7	Brass
8	Bronze
9	Copper

Tab. 1: Material groups

For that reason no universally valid conversion table for all materials can be specified. Therefore, conversion tables for different materials groups shown in Table 1 were determined experimentally (see Fig. 4), which allow to convert the measured Leeb value HL into the needed hardness scale.

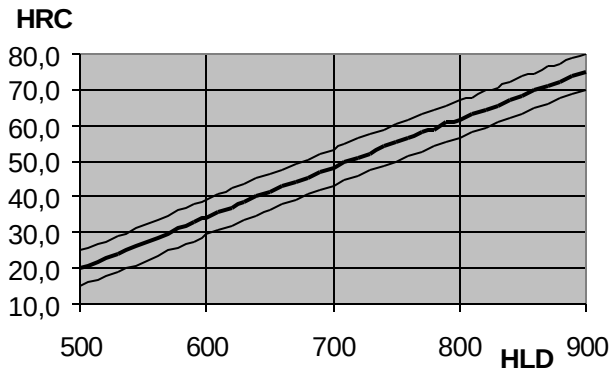

Fig. 4: Conversion of Hardness Leeb, HL, into HRC as a typical example for conversion tables stored in rebound hardness testers. These curves are experimentally generated by material samples of different hardness measured by rebound and Rockwell test.

To carry out the measurement it is necessary to select the appropriate material group in order to ensure a correct conversion into the selected hardness scale.

Conversion tables for the common hardness scales are given in the ASTM E 140 or DIN 50 150 standard. But it is to consider that those tables are only valid for unalloyed and low-alloyed steel grades, and therefore reflects material group number 1 (see Table 1). If measurements have to be carried out on high-alloy steels or other materials, e.g. nonferrous metals, then the instrument has to be adjusted to the suitable material group. In this case the ASTM and DIN conversion can’t be used and the hardness scales are converted using the instrument specific tables obtained experimentally (Fig. 4).

New and modern instruments have stored such conversion tables allowing for automatic display of the measured hardness in the selected scale.

For situations where some existing materials do not fit into any material group for hardness conversion, newer rebound hardness testing instruments offer the possibility to generate specific conversion tables.

By using a special utility software own tables can be created. For that purpose it is necessary to determine a suitable number of hardness value pairs, consisting of the Leeb hardness value obtained by a rebound hardness tester and the corresponding hardness value of the scale in which the measurement should be converted (e.g. using a Rockwell hardness tester).

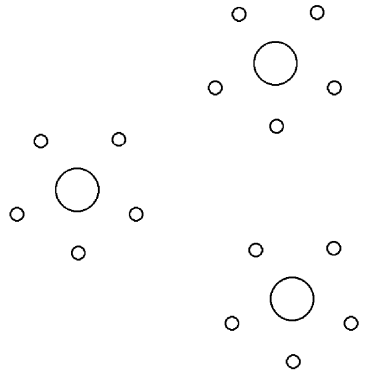

Fig. 5: Determination of pairs of hardness values (Creating own conversion tables)

It is recommended to measure the average from at least 10 – 15 adjoining HL values and at least 3 statical values as a basis for a value pair as shown in Fig 5.

Using those value pairs as input, the computer program calculates the specific conversion, which than can be stored in the instrument.

3. SUMMARY

Although the Leeb hardness testing with a different measurement principle leads to a “new hardness scale”, which so far is not used in common engineering, conversion tables stored in the instrument allow to measure the hardness in standard scales.

Modern rebound hardness testing instruments, therefore, offer a fast, reliable and economical alternative to standard bench-top hardness testers

REFERENCES

(1) Leeb, D.: Definition of the hardness value „L“ VDI Berichte 583 (1986), 109-133.