GMP 1

Good Measurement Practice for Reading Turning Points on an Equal-Arm Balance

The damping of the beam oscillations of an equal-arm balance is generally very slow. Consequently, it is practical to read the turning points (the highest and lowest value of the beam oscillation) on the graduated scale and use the sum of the turning points as the observation value rather than wait for the beam to come to rest. This GMP requires that the graduated scale be numbered such that adding weights to the left arm increases the readings.

Suppose the graduated scale has 20 graduations that are numbered from 0 to 20. The loads on the balance arms should be adjusted so that the sum of the turning points is approximately twice the midscale reading. In this example, the sum of the turning points should be within one division of twenty. Turning points should be estimated to at least 0.1 division in this example, which is typical of the Russell balance. This means that the final rest point is approximately 10, the midscale reading. Motion to the beam may be induced or dampened so that the turning points can be read easily. Care should be taken so that the beam does not hit limiting stops during its normal oscillation while turning points are being read. The amount of the beam oscillation is not critical although a span of from three to ten divisions is adequate.

Once motion has been induced for the beam oscillation, wait for at least one complete oscillation cycle for the beam motion to stabilize. After this time, the turning points can be read. The readings may begin with either the high or low turning point. The turning points for at least two consecutive oscillation cycles should be recorded. The turning points should reveal a consistent pattern of slow damping; that is, the turning points should gradually converge to the eventual rest point. For example, if the last high turning point was greater than the previous high turning point (if the readings normally drop on successive readings), this would indicate that something has interfered with beam oscillation, hence the last reading was not valid with respect to the previous readings. Under these circumstances, turning points should continue to be read until a consistent damping pattern has been obtained. In some cases, the balance oscillation will dampen so slowly that the same readings may be obtained for several oscillations before a decrease is observed. These readings are valid and may be used to compute the sum of the turning points.

When at least four satisfactory turning points have been obtained (two high and two low turning points), all but the last three readings should be discarded. This will leave two high and one low turning point or vice versa. <u>The two readings for the high or low turning points should be averaged and added to the single turning point to obtain the sum of the turning points</u>. The sum should be carried out to two decimal places if the second decimal place digit is nonzero. As an example, the following readings were obtained: 15.5, 4.3, 15.4, 4.4. The sum of the turning points is computed as shown in Eqn. 1:

$$\left(\frac{4.3+4.4}{2}\right)+15.4=19.75 \qquad \text{Eqn. (1)}$$

This technique of reading turning points has been successfully used to obtain readings on a digital loadcell system where the overall hoisting system is not sufficiently rigid to allow stable unchanging indications when under load. If there is a slowly oscillating digital variation, where the readings seemingly wander back and forth around a central value on a period of at least 5 seconds, it may be appropriate to read a series of maximum and minimum values and calculate the central value using the turning point method. Turning points have been used with loadcell systems to calibrate weight carts and large weights suspended from an overhead hoisting system where there was a slow indication oscillation caused by flexing of the overall supporting structure.