

AUTOMATIC TURNTABLE DESIGN FOR 500 kg BALANCE

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ABSTRACT

An automatic turntable system was designed for 500 kg mass comparator. The turntable system was constructed in one piece due to dimensional stability and calibration of cylindrical also rectangular shaped weights between 100 kg and 500 kg weights. This system is controlled by PLC, optionally it is possible to use manually.

1. INTRODUCTION

Mass comparators are used to determine the highest accuracy of mass. It is well known that for decreasing the random error in mass calibration results, measurements are repeated more than one. These repetitions bring in some disadvantages particularly when manual operations are done. Firstly, in each measurement, weights may not be placed accurately at the center of pan in this respect different readings are obtained from balance indicator. Secondly, in manual operation long waiting time is needed to reach stable measurement results. When doing high accuracy measurements, for avoiding drifts the waiting time must be the same, otherwise drift correction requires on measurement results.

Much weight handler design for high capacity mass comparators has been done by Metrology Institutes [1-3]. An automatic turntable mechanism was designed for 500 kg mass comparator avoiding effects as indicated above. With automatic weight changer device top loaded mass comparators operate under computer control to automatically load weights on and off the weighing pan. Readings are sent to computer and mass measurements may be carried out under full computer control and eliminated tedious, time-consuming; operator disturbance and drift correction depends on different waiting times.

In this paper, an automatic turntable of 500 kg mass comparator manufactured and designed for measurements between 100 kg and 500 kg was described and performance test results were shown.

2. DESCRIPTION OF MEASUREMENT SYSTEM

2.1. MASS COMPARATOR

An automatic turntable of 500 kg mass comparator is shown in Figure 1.



Figure 1: General view of automatic turntable system

The weighing instrument is an electronic top loaded balance (Mettler KC500-1) with a maximum capacity of 600 kg, a resolution of 0.1 g, and repeatability is 0.3 g in manual operation for 500 kg weight. The balance has levelmatic pan to reduce the effect of corner load errors to the minimum level. In order to measure at the same point a disc that is 475 mm in height and 350 mm in diameter is placed center of the weighing platform. The disc is made of an alloy consisting of aluminium and magnesium. During the weighing operation the weight lies on the disc. With this arrangement the lowering and rising of the weight is done as smooth as possible. The balance is placed on the marble block height of 710 mm and width of 830 mm on the seismic mass.

2.2. TURNTABLE AND OPERATION

Figure 2 shows the turntable mechanism. It was constructed as in one piece because of the need for dimensional stability and rigidity; its total weight is approximately 2900 kg. The turntable was attached to main spindle and placed on frame base that consists of axial bearings. Not only do these balls minimize friction, but they also increase resistance of the turntable and carried axel loads during to rotate the turntable. The turntable is rotated by electrical DC motor placed on the turntable which is moved up and down by other an electrical DC motor at bottom side of the system (see figure2 (b)). Four linear roll bearings are used for minimizing friction and lowering or lifting load at the same direction. The linear roll bearings can be defined to guide.

The maximum range of up/down motion is 100 mm. The rotating speed is 1 to 2.5 period/minute and lifting/lowering speed is 0.3 to 19 period/minute also the speed can be adjust by a frequency converter The turntable has four pans for weights W1 to W4, pans were made of an

alloy consisting of aluminium, magnesium, and designed according to shape of weights from 100 kg to 500 kg as cylindrical and rectangular.

Programmable DC speed motors are used to move up/down and rotating motion, so that the computer has full over the speed and positioning of the turntable. Since the system has PLC control, position information for the computer is provided by position sensor on the vertical movement, besides laser is used that provides to lie reference point of pans after rotating of turntable. There are proximity switches, which check whether or not the weights are on pans, so they are placed on the hanger of support tables. During the weighing operation the weight to be calibrated is lied on the disc center of the balance. The other pans are lied on the disc of the support tables are placed to rescue load to the turntable and increasing material life-time and productivity of the turntable system.

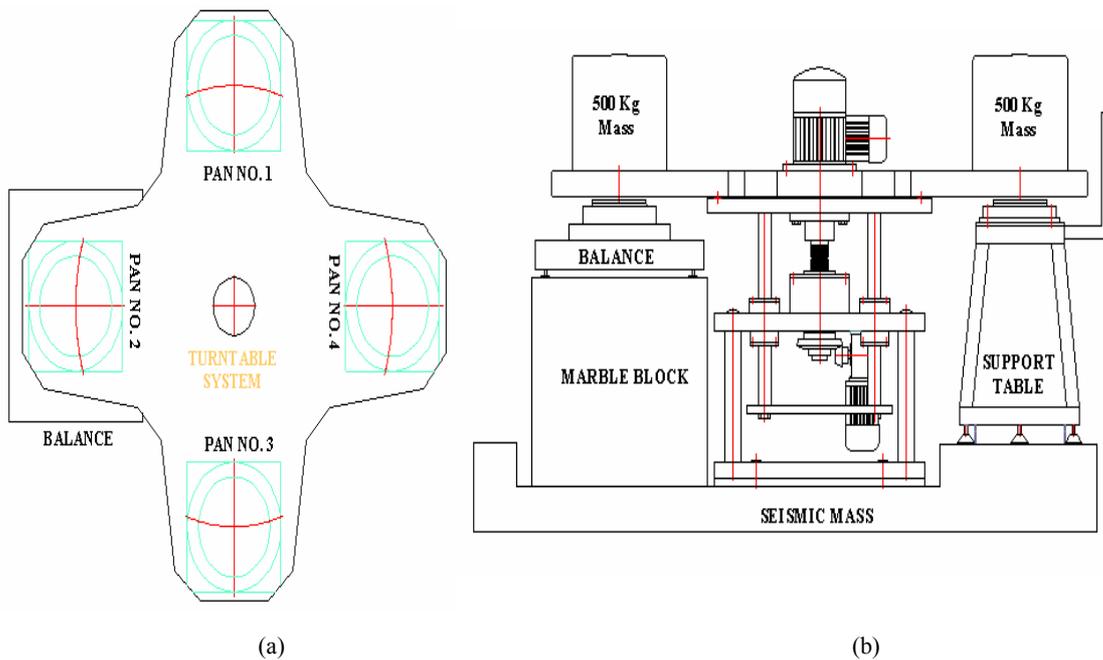


Figure 2: (a) Top view of turntable system, (b) Front view of turntable system

Communication process between computer and turntable system is supplied through an RS 232 interface by utilizing an I/O card, there are two emergency stoppers settled for mechanical safety. The control of electronics is an interface between computer and motors In the case of adjustment of weights the turntable system is enabled to manual operation. The measurement is implemented according to substitution method as R-T-T-R or R-T-R .

3. MEASUREMENT RESULTS

The performance of automatic turntable system was observed by measurement of 500 kg mass also deviations between pans according to measurement results of 500 kg mass were analysed. It is shown in figure 3 changes between average values and series of 500 kg mass for various pan numbers. The average value changes between 5.3 g – 6.5 g, and the average value of twenty series is 5.8 g for pan number 1.

On the other hand, the average value changes between 5.7 g – 6.4 g and the average value of twenty series is 6.1 g for pan number 3, and the average value varies between 5.7 g – 6.3 g. 5,9 g as an average value is procured for the pan number 4.

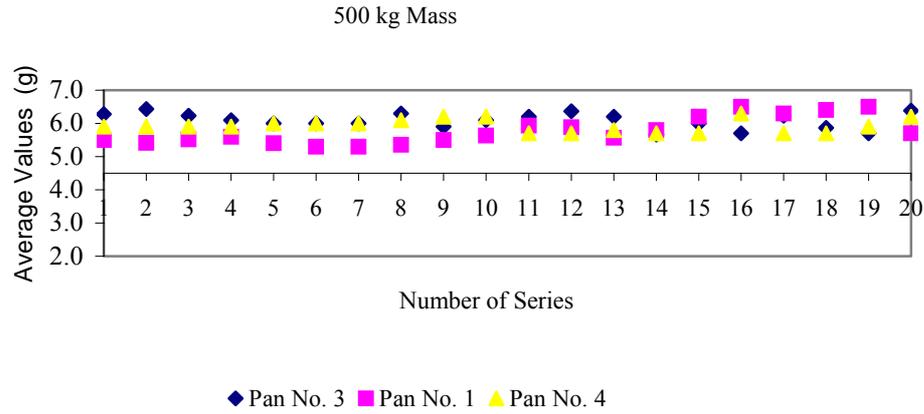


Figure 4: The average values in various pans of 500 kg mass

The standard deviation of twenty series is 0.4 g for pan number 1, 0.2 g for pan number 3 and 0.2 g for pan number 4.

4. CONCLUSION

As it is known that manual loading in high capacity mass measurements by operator, brings some problems such as displacement of weights on center of balance pan, or different indication values obtaining from balance indicator because of instability of measurements, long waiting times need and errors of operator.

From this point of view an automatic turntable system was developed for 500 kg mass comparator to reduce random error included in measurement uncertainty budget and to eliminate problems as indicated in paper, so the performance of automatic turntable system was observed. by measurement of 500 kg mass and deviations between pans according to measurement results of 500 kg mass were analysed. The results showed good agreement between the pans and twenty series of measurement results, which consist of six cycles.

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