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A METHOD OF TESTING THE ACCURACY OF A FLOAT GAUGE

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institute of coastal oceanography and tides

NATURAL ENVIRONMENT RESEARCH COUNCIL

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This Report was prepared before the Tidal Institute became the Institute of Coastal Oceanography and Tides.

I Some time ago our attention was drawn to a short note by a French engineer named van Casteele, in which a method was described for testing the overall accuracy of a tide gauge. The method seemed to have many virtues which could recommend it to the Ordnance Survey Tide Gauge Inspection Parties, and after discussions with Colonel Kelsey we agreed to try it out on the Légé gauge belonging to the Tidal Institute.

Procedure:

This is quite simple and consists of taking well soundings and simultaneously noting the pen reading at intervals thoughout a spring tidal cycle. The soundings were taken using a high quality surveying tape, contact with the water surface in the well being indicated by an electrical circuit. Each set of 5 readings was averaged, and the operation repeated at intervals of approximately 15 minutes.

Knowing the height of the tape zero chart datum, and the height of the tide gauge zero relative to chart datum, the tape readings were then converted into sea level heights (T) which were compared directly with the readings of the recording gauge pen (R).

When the values of T were plotted as ordinates against R-T as abscissae, the resulting diagram was most illuminating.

II Results of test No. 1 on Légé gauge, Birkenhead.

The spring cycle of 10 July, 1964, with a range of 29 feet was chosen, and the observations taken over a period of hours by Mr. R.H. Jones.

The results are illustrated in Figure 1 and the following points were noted.

(1) The mean value of R-T over the tidal range is 0·15 ft. This is the mean error in setting the pen on the chart and may be corrected on the Légé gauge by a friction device designed for that purpose. This mean error may change when the chart is replaced, and it is the custom of the Tidal Institute to determine the error weekly by well soundings and correct the records accordingly, rather than to be repeatedly adjusting the pen setting.

(2) The curve for the rising tide is displaced from that for the falling tide by approximately 0·11 feet. The chronological path being clockwise, this indicates friction in the gauge; for a frictionless gauge the loop would become a single curve.

The following possible sources of friction were investigated :

(a) Dirt on moving parts, and lack of oil

(b) The drag of paper on pen during the falling tide (the pen can then be lifted out of its seating).

(c) Backlash in gearing.

(3) The twist in the diagram at high water. This indicates a non-linear response in one or more stages of the recording mechanism; a linear response in a frictionless gauge would produce a vertical straight line graph.

The following possible sources of non-linearity at high water were investigated :

(a) Overlapping of turns of the float wire on the float wire pulley.

(b) Overlapping of the pen carriage wire on the associated double pulley.

(4) The twist in the diagram at low water. Here again the most likely source of error is 3(b).

(5) The amount of scatter is believed due to a combination of backlash and the small height scale of the recording paper.

III <u>Results of Test No. 2 on Légé gauge, Birkenhead</u>.

The Test No. 1 conducted on July 10th, 1964, indicated possible sources of error. After an examination of the mechanism and after certain adjustments had been effected, a further test was performed on September 8th, 1964, when a tidal range of 30 feet was observed. It is significant to note by comparison that the mean spring range at Birkenhead is 27•5 feet and the mean neap range is 15•0 feet.

The results of this further test are illustrated in Figure 2 and show a considerable improvement.

1. The mean value of R-T is 0•305 feet. For reasons explained in the earlier report, this is a function of chart and pen adjustment and can be ignored in this context.

2. The curve for the rising tide is displaced from that of the falling tide by approximately 0•03 feet. The previous test gave a displacement of 0•11 feet. The improvement can be attributed to the attention paid to friction and backlash.

3. The twist in Figure 1 near to high water has now been eliminated by :-

   (a) Replacing the float wire, at the same time taking care that the wire length is sufficient only to reach to the minimum level capable of being recorded on the chart. In this way the danger of riding turns on the float pulley is sufficiently reduced.

   (b) The pen carriage traverse was adjusted so as to shift any error caused by riding turns on the pen carriage drive to the vicinity of low water. In this way the recording of high waters and surges near to high water can now be achieved without error, and this is considered to be an important function of this particular gauge.

4. The twist at low water is slightly increased as a consequence of 3(b).

5. The degree of scatter is considerably reduced after attention to the backlash in the gearing.

Although it is most disappointing that any tide gauge should have a non-linear response curve at all, nevertheless the above test now shows that this particular Légé gauge has a tolerable performance.

The maximum error recorded was of the order of -0•06 feet and this at a level of approximately 1 foot above datum.

Within the range of the average spring tide, the maximum error was found to be -0·05 feet at low water and within the range of an average neap tide the maximum error was found to be +0·03 feet.

These errors should be evaluated in relation to the normal reading accuracy of tidal levels viz. 0·1 feet, and at the same time consideration should be given to the fact that each depends upon a single tape sounding of the tide gauge well.

For Mean Sea Level purposes the significant criterion of accuracy is the mean error over the tidal cycle.

The mean error found in the large tidal range observed on September 8th was -0·007 feet.

The observations also suggest that for an average spring tide, the mean error is of the order of -0·001 feet and for an average neap tide +0·001 feet. The latter figures are well within the limits of observing accuracy.

It is considered to be highly desirable to compare the performance of this Légé gauge with that of gauges supplied by other manufacturers on the basis of similarly devised tests.

IV The results of this test emphasise their value. Other gauges and other installations will give different shaped diagrams, and hence will lead to the diagnosis of other types of defect. If the tape soundings could be accurately performed in the open sea as near as possible to the gauge well, this should also give an additional check on siltation of the connecting pipe.

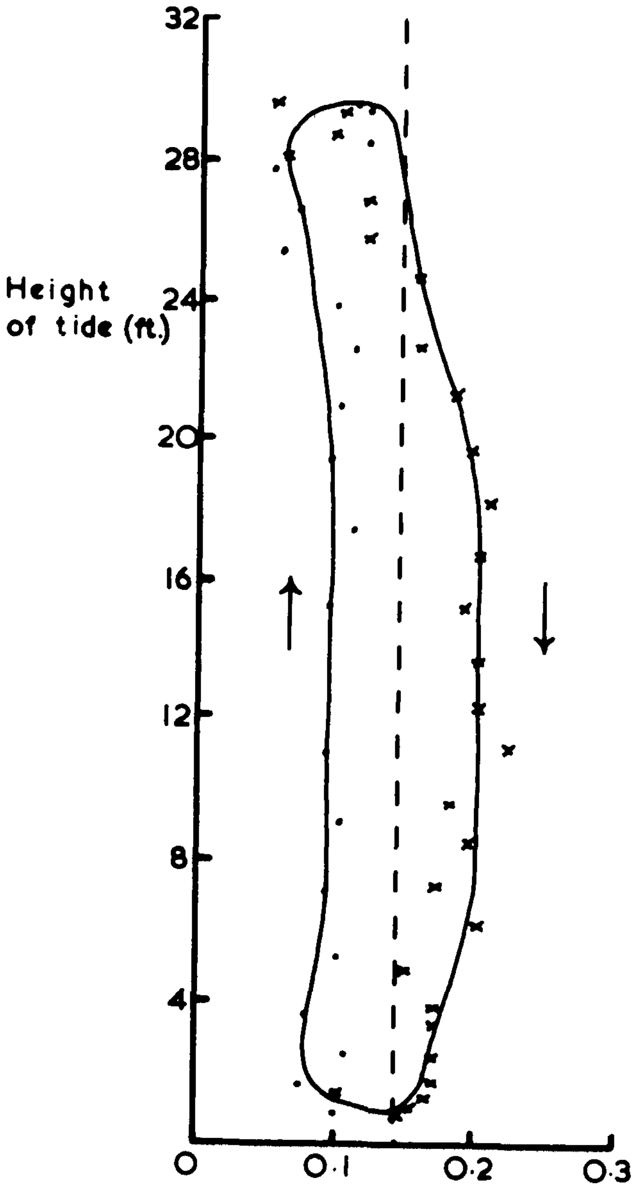

Figure 1

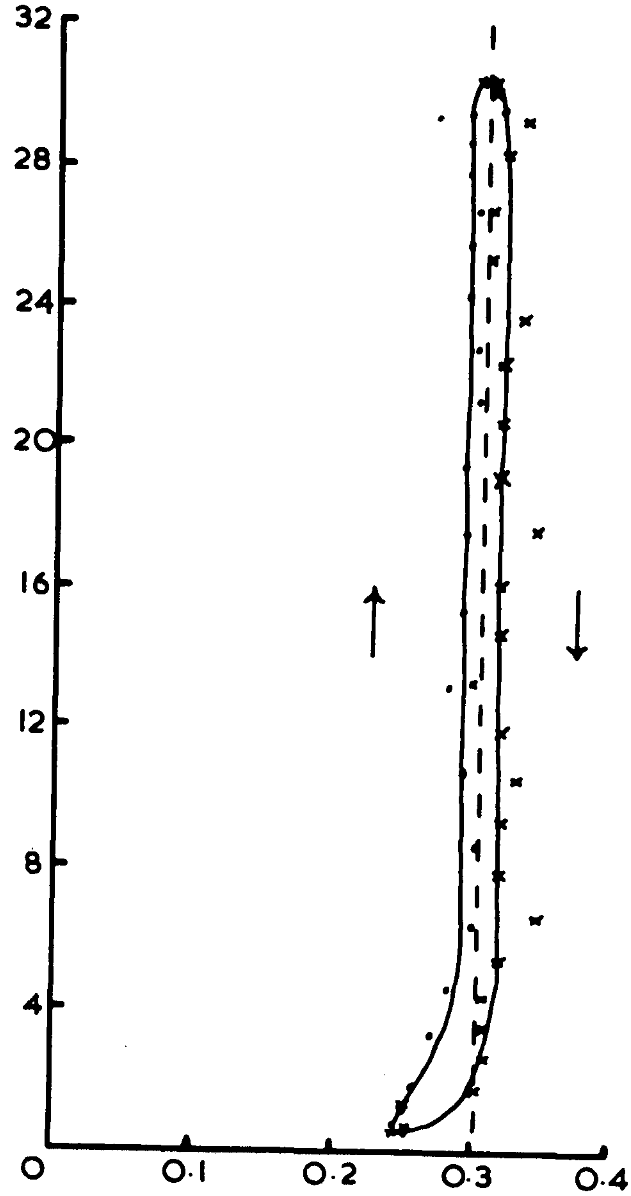

Figure 2

Errors in gauge recording. (ft.)