THESIS

DESIGN FOR AN APPARATUS TO DETERMINE MOMENT OF INERTIA OF IRREGULAR SOLIDS BY IMMERSION

R. L. Reynolds.

Solids

Sobrado

Thesis by R L Reynolds

Design for an Apparatus to Determine Moment of Inertia of Irregular Solids by Immersion.

It is frequently desirable to know the moment of inertia of irregular pieces, and, although there is a graphical method for determining this, it is so tedious as to be almost useless. The method by immersion is claimed to be a very close approximation and with proper apparatus would be very easy of application.

In 1894 Messrs. Simmons and Pashy wrote a thesis on the method and on a test of it, made without any special apparatus for dipping, in which they found that it was correct to within one per cent as compared to an exact graphical method.

This test demonstrated clearly the correctness of the method, but in order to make it valuable it must be easily applicable; and to accomplish this it required some means of rapidly dipping the piece about half an inch at a time, and measuring the water displaced each time. The piece must be dipped by exact increments, and the water accurately measured.

The apparatus as finally constructed is shown in the accompanying photograph. The piece is dipped and the distance automatically measured by the screw, which is four pitch single thread, and 1 1/2" diameter. This screw is turned by the hand wheel which has an attachment by which the screw is stopped at the same point of the revolution every time. The screw is supported upon brackets which are attached by lag screws to a pillar. The upper bracket contains a horizontal adjusting device by which the screw is brought to an exact vertical. The weight of the piece dipped, and that of the screw and crossbeam is supported on a ball bearing in the lower bracket. This is very necessary as ease of turning is very desirable, and with heavy pieces could not be attained without ball-bearing.

The piece to be dipped is held by two pointed set screws threaded into a clip which is attached to one end of the crossbeam. The piece hangs 18" from the screw and must be counter-ballanced in some way. This is accomplished by extending the crossbeam 6' in the opposite direction and suspending from it a 30# weight at such a point as to exactly balance the weight of the piece. The crossbeam is bolted to a nut working on

the screw and unless exactly balanced it causes great friction. For this reason the weight of this long projection of the crossbeam was almost but not quite equalized by a weight running over a pulley and attached to the end of it. A small part of the weight of the crossbeam is left unequalized in order that the tendency to tip may be always in one direction and so prevent error from back lash. If the surplus weight was left on the other side it would be neutralized by the water displaced by the piece.

The water in which the piece is dipped is contained in a large tank 5' high, and 3' long, and 2' wide. This piece is dipped in the center, and the water flows over a knife edge weir into a brass tube and from there into a bucket in which it is weighed on a scales weighing two hundredths of a pound.

After the apparatus was set up an attempt was made to test it by dipping some regular pieces of which the moment of inertia was known. The test was a failure but it did not show that the apparatus was not a success. With the exception of the tank and weir every part worked perfectly. The trouble was to keep the level of the water in the tank exactly the same. It would pile up on the weir and then all come down at once. This may have been due partly to dirt in the water, but even with perfectly clean water the vibration of the building due to the engine made the results very irregular.

The reason for this difficulty is not hard to find. The piece dipped was only a very small test piece, and its total immersion would only have raised the level of the water a little less than 1/13". Therefore, as the piece was 30" long, the difference of level for each 1/2" increment would be only a little over 1/1000". With the refinements used

it was impossible to keep the level within 1/1000", and for accuracy it needed to be kept closer still. Of course this was only a test piece and the pieces actually used would be much larger. It remains to be seen whether the tank as built will do for them. Lack of time alone prevented the trial of the apparatus with pieces suitable to the size of tank.

Certain it is that the apparatus would be successful with a tank having not more than 11 times the cross section of the piece, for then the rise in level of the water would be 1/10 of the increment of dip, and the level need not be kept so exactly at the same height. The objection to this is that in that case one tank would not serve for all pieces and it is to be hoped that the present tank may yet give satisfaction in all cases.