Report on Tests for RDT Chamber Solutions Ltd
By
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1. Introduction

RDT Chamber Solutions Ltd, produce a rectangular four sided GRP box configuration for use in manhole chambers. Each side is in the form of a channel in section and these are bolted together at the corners to mate at right angles. Vertical stiffeners are also included near each corner. Tests were required to quantify the load-deflection behaviour of the boxes for a different number of boxes, and a side load test on one box was also to be carried out.

2. Equipment

The load-deflection tests were at two levels; up to 40kN (half a standard axle load) as the boxes were built up to a height of 900mm (6 boxes) and a high load test at 200kN for this final height. The side load test was carried out at 6kN and 12kN.

Figure 1 shows that the test arrangement which utilises a portal frame bolted to the laboratory floor and fitted with a hand pump operated hydraulic actuator. This actuator applied the load to the boxes through a load cell positioned on a 240mm diameter loading platen, which was placed centrally over a cover and frame supplied by Saint Gobain Pipelines Plc. Vertical deflections on the top of the frame at the centre of two opposite sides were measured with dial gauges, and with linear potentiometers at a similar location but on the horizontal flange. Horizontal deflection on the opposite sides of the chamber were also measured with linear potentiometers.

Dial gauges provided instant readings and the potentiometers gave output voltages proportional to deflection which were recorded on a data logger and processed after the test. All these instruments measured deflections relative to the laboratory floor.

3. Procedure

Load was applied in 5kN increments up to 40kN for one, two, four and six boxes, with several repeats for the six boxes so that the potentiometers could be moved to different locations. As the test progressed load and deflections were recorded.

The high load test on six boxes was carried out in 10kN increments, up to 100kN and then in 20kN increments up to 200kN. In this case vertical deflection was measured on the 240mm diameter loading platen, either side of the load cell, and horizontal deflection was measured at the centre of the top box on either side. Again readings were relative to the laboratory floor so vertical deflections comprise a total movement of the top of the platen to the bottom of the chamber. A displacement transducer which measured deflection between two fixed points was attached vertically within the channel section of the box at one corner. By dividing the displacement (deflection) during loading by the distance between the two points it was possible to determine strain at a position where the load was transferred to the corners of the frame for this type of non rock cover.

A side loading test on one box on its edge was done with the platen placed on the centre of the upper side. Initially the box was required to support a load of 6kN but at the time of the test the load was also taken to 12kN.

4. Results

Figure 2 shows the dial gauge deflections for the tests up to 40kN for one, two, four and six boxes. The repeat tests are related to changes to the positions of the potentiometers and are described in that section of the report.

The readings are the average of the two gauges and their validity was checked by moving the six box chamber through 180^o for the final repeat test.

It can be seen from Figure 2 that there is an accumulation of deflection as would be expected as the number of boxes increase and the rate of deflection reduces slightly with an increase in load. In most cases the recovery shown by the single straight line returning from the maximum reading to zero load is close to zero deflection, which is characteristic of an elastic material. Results for the six box tests would be expected to be similar and readings for tests c and d so close that they were superimposed. The single points at 25kN and 40kN are the final repeat test with the six boxes turned through 180^o

Figure 3 is intended to simplify figure 2 and is the final average deflection at 40kN against the number of boxes. This relationship is linear for one box onwards and if projected back to zero load the intercept would represent the seating effect between the frame and the boxes and between the boxes as the loading is applied.

Figures 4 and 5 are a repeat of figures 2 and 3 but from the potentiometers on the frame flange and give slightly lower readings due to the different locations, but the trends are identical.

Figure 6 shows the results from the repeat tests for 6 boxes, (figure 4) and compare the potentiometer readings on the corner of the frame flange and on the corner of the top box respectively with the flange centre readings. The corner readings are less than for those on the frame as a consequence of being at a stiffer location. Identical results are obtained on the corners showing that the flange is well seated on the box.

Figures 7 to 11 are for the horizontal deflections measured by the potentiometers and were obtained during repeat tests a, b and c. Readings in a positive direction are for the plunger on the potentiometer moving inwards so that the surface of the box is moving outwards. This convention does not apply to the vertical deflections as these all move downwards. There is no real trend to the results other than the single box gives the lowest readings. The objective was initially to see if the boxes were sliding, in which case readings of the opposite sign would have been recorded. This does occur in some cases, but where the direction of movement is the same the potentiometers could be measuring slight outward bending in the box section. The magnitude of this would vary depending on the accuracy of the location of the potentiometer relative to the centre of the section and would be affected by any slight variation in loading from one side to the other.

Results for the high load test are presented on Figure 12. Again the stress stiffening effect is evident and the 200kN load on the RDT chamber system was readily achieved. Only a slight and short length of delamination was noted on one box. The horizontal readings on opposite sides of the centre of the top box are given in Fig. 13.

The vertical strain in the wall of the top box near the corner is shown in figure 14. Below 50kN the strains are below 100 microstrain and then increase as the loading in the corners from the frame is transferred from the seating effect on the flange of the boxes into the wall. It is not possible to relate this to the total strain of the chamber as the strain distribution with depth is not known.

The side load test was done on one box on its side through a load cell onto the circular platen. It was necessary to use a packing piece under one side of the platen as the top and bottom channel flanges were of a slightly different width. Initially a load of 6kN was applied giving a deflection of 6.5mm with no sign of mechanical failure. The load was then increased to 12kN and held for about one minute without failure although significant bending was apparent as the deflection reached 12.8mm.

5. Conclusions

The vertical load-deflection behaviour of the RDT GRP chamber at loads of up to 40kN and then up to 200kN was defined. These tests gave final deflections of 3.4mm measured on top of the frame and 14.3mm measured on top of the platen at 200kN. It is not expected that the frame will deflect significantly so the 40kN test is representative of the chamber deflection at a mid point along the sides. However, the 200kN test results will include the deflection of the cover but this is how the test was required to be carried out.

For the side load test the box was seen to be capable of supporting loads of 6kN and 12kN.

The aforementioned tests were the main objectives but supplementary tests to measure side deflection and strain in the wall were carried out. In the event the causes of the side movements were difficult to isolate but it was seen that all readings were below 0.7mm. A reading of strain near the corners for the 200kN test showed no sign of a rate of change increase which would be expected if failure was being approached.

For all of this work the chamber is in an unconfined state and vertical deflections would be expected to be less in a pavement installation as the sides would be supported. It should also be noted that the loads are distributed into the corners of the ironwork frame and all the results are presented for the load applied to the centre of the cover.

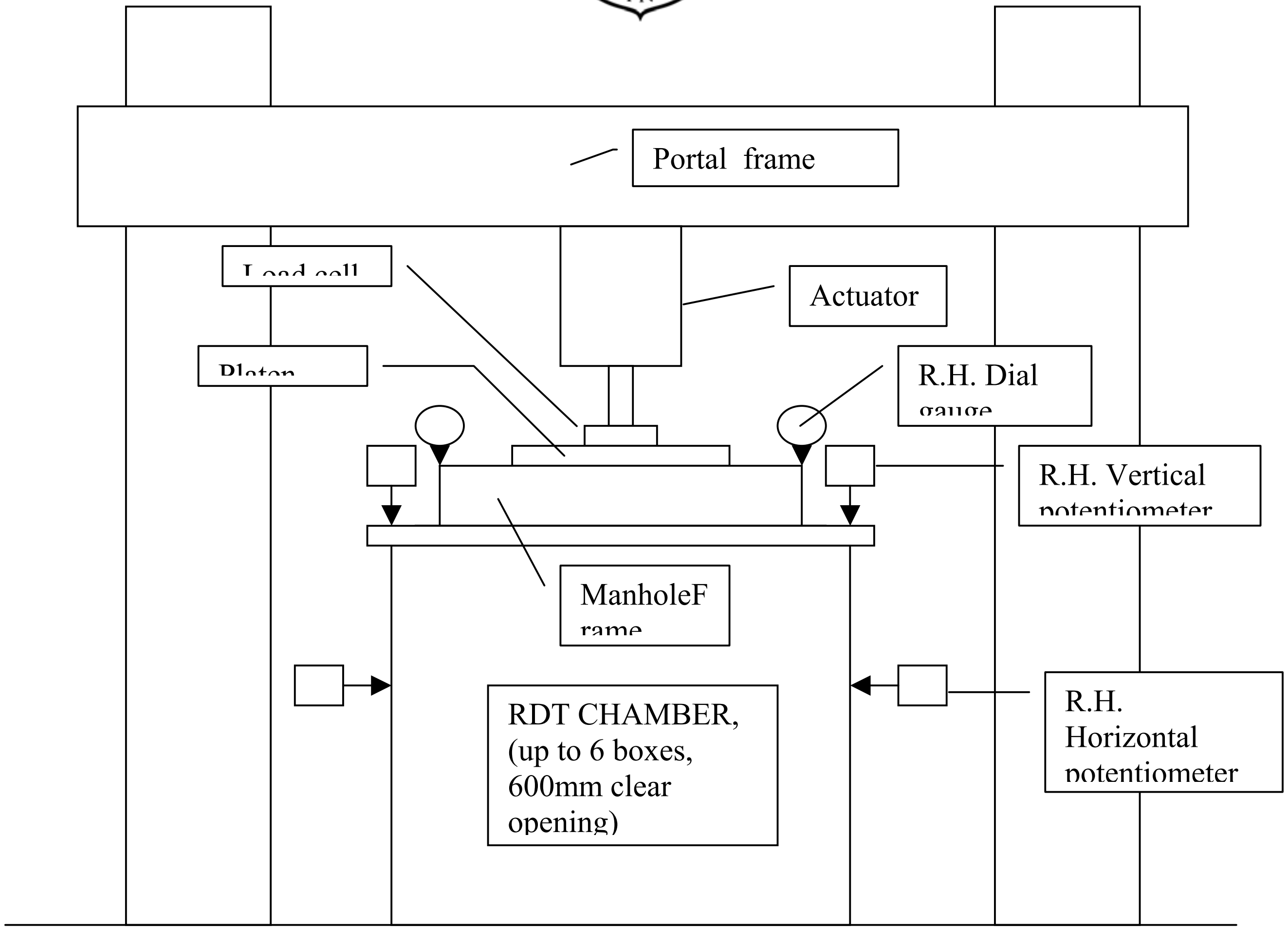

FIG 1 TEST ARRANGEMENT

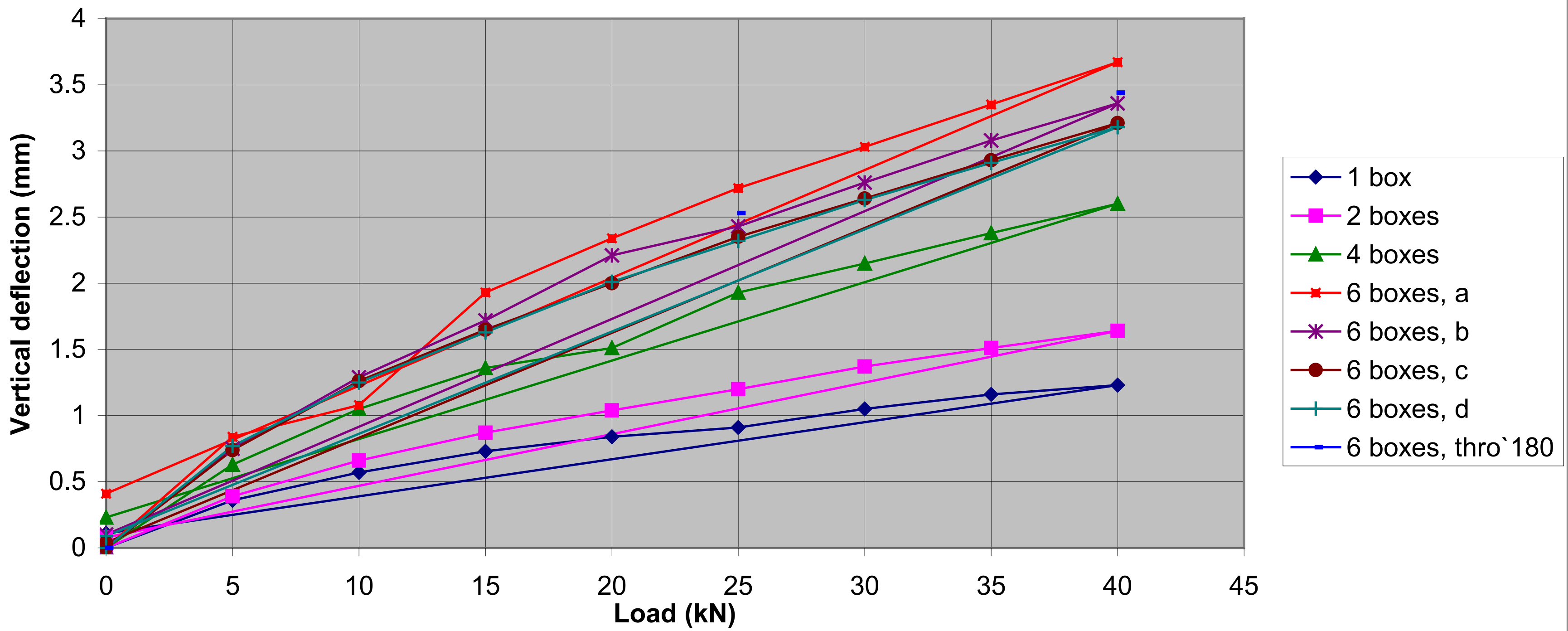

FIG2 LOAD/DEFLECTION TESTS ON RDT BOXES, 600mm opening, vertical deflection measured on the centre of the top of the frame with dial gauges

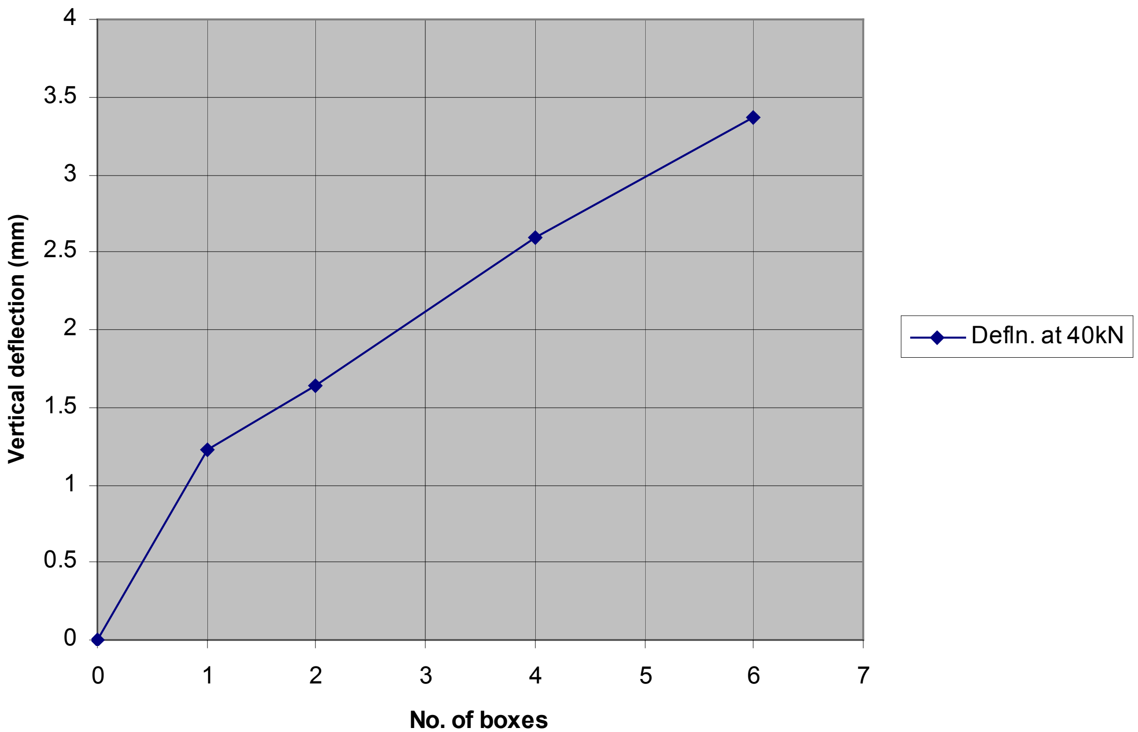

FIG3 DEFLECTION ON TOP OF THE FRAME AT 40kN FOR NUMBER OF BOXES

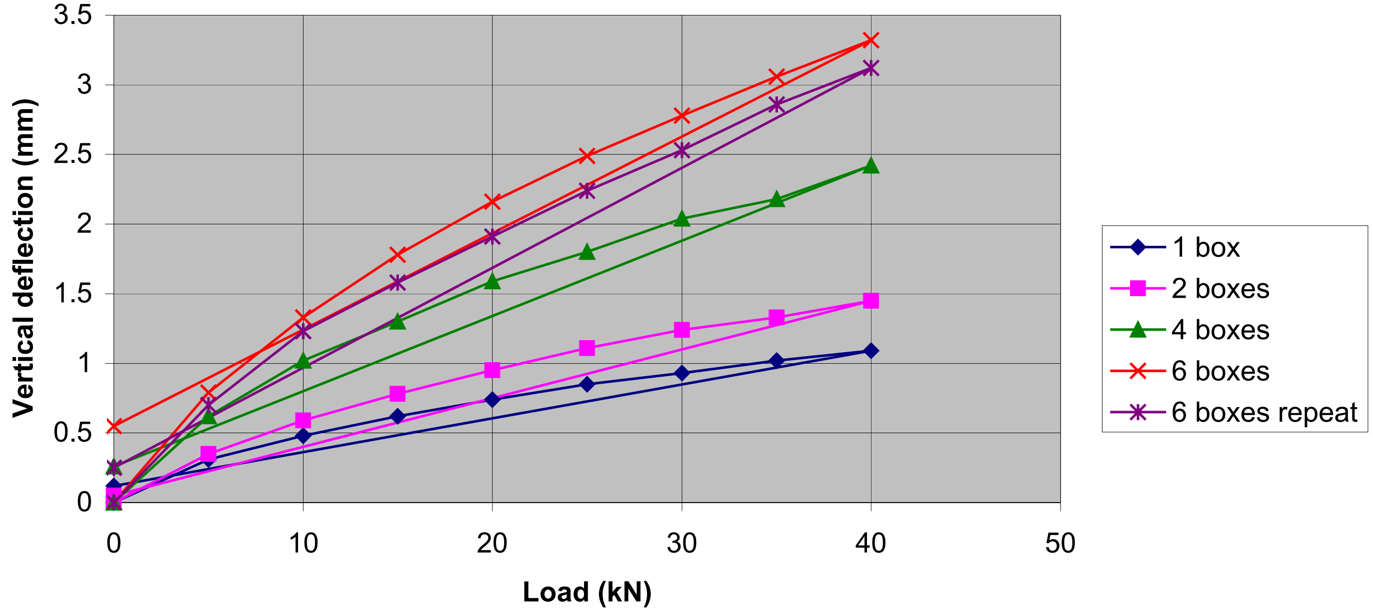

FIG4 LOAD/ DEFLECTION TESTS ON RDT BOXES, 600mm opening , vertical deflection measured on the centre of the flange of the frame with the potentiometers)

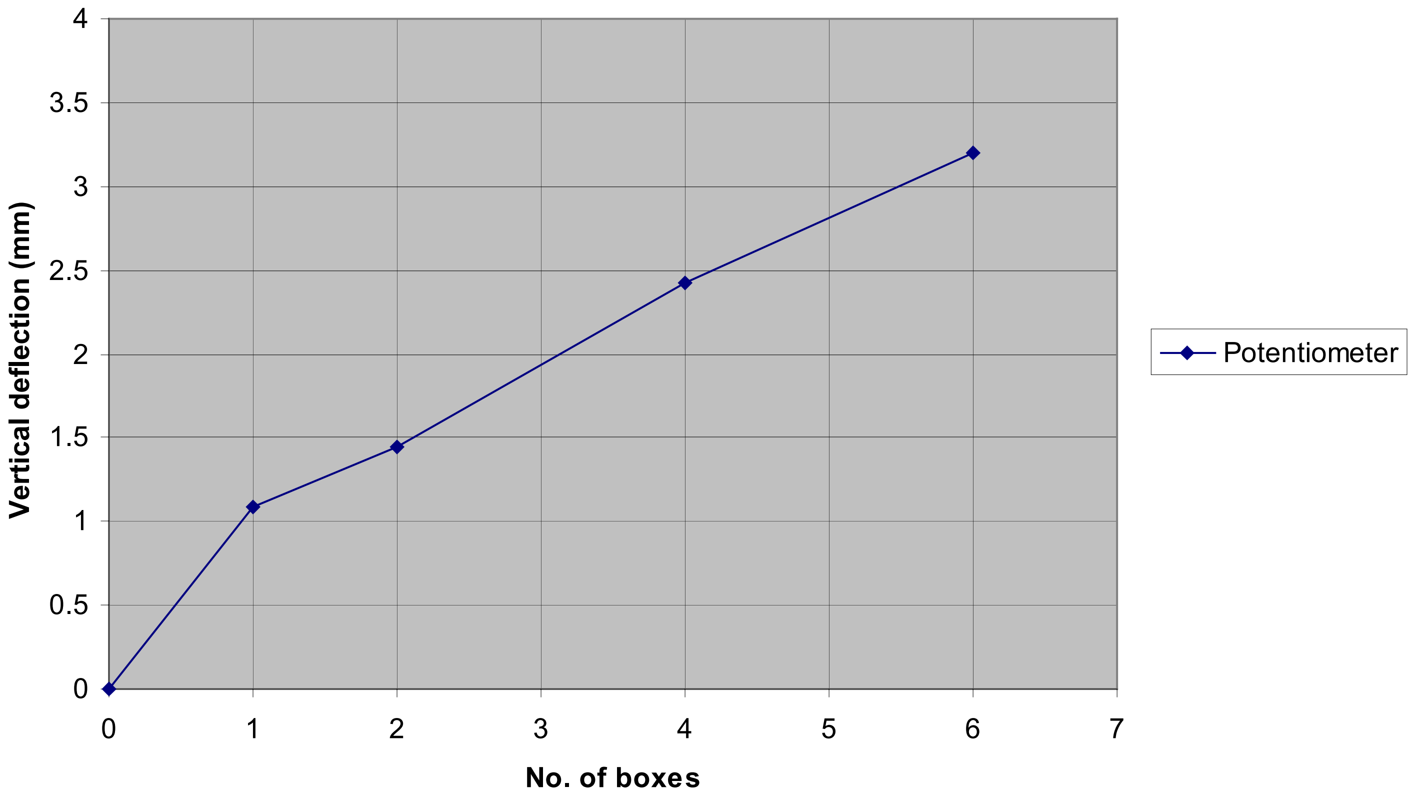

FIG5 VERTICAL DEFLECTION ON CENTER OF FRAME FLANGE AT 40kN

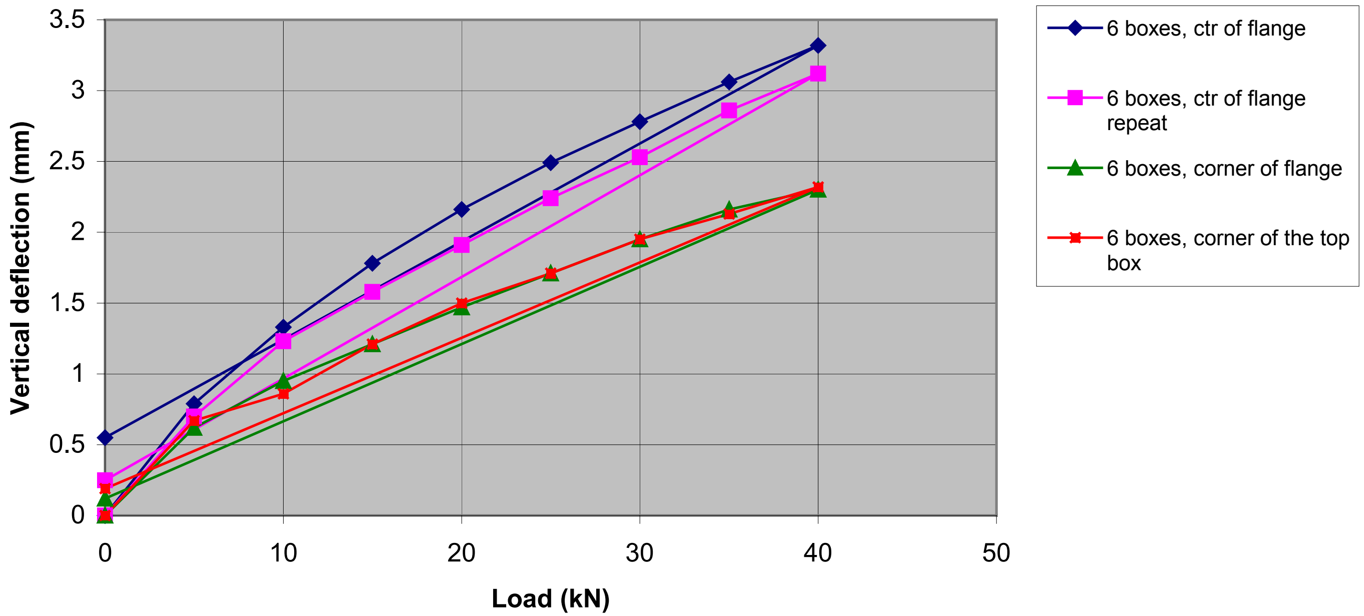

FIG6 LOAD/DEFLECTION TESTS ON RDT BOXES, 600mm opening, vertical deflection measured on the centre of the flange and on the corner of the flange and top box with the potentiometers.

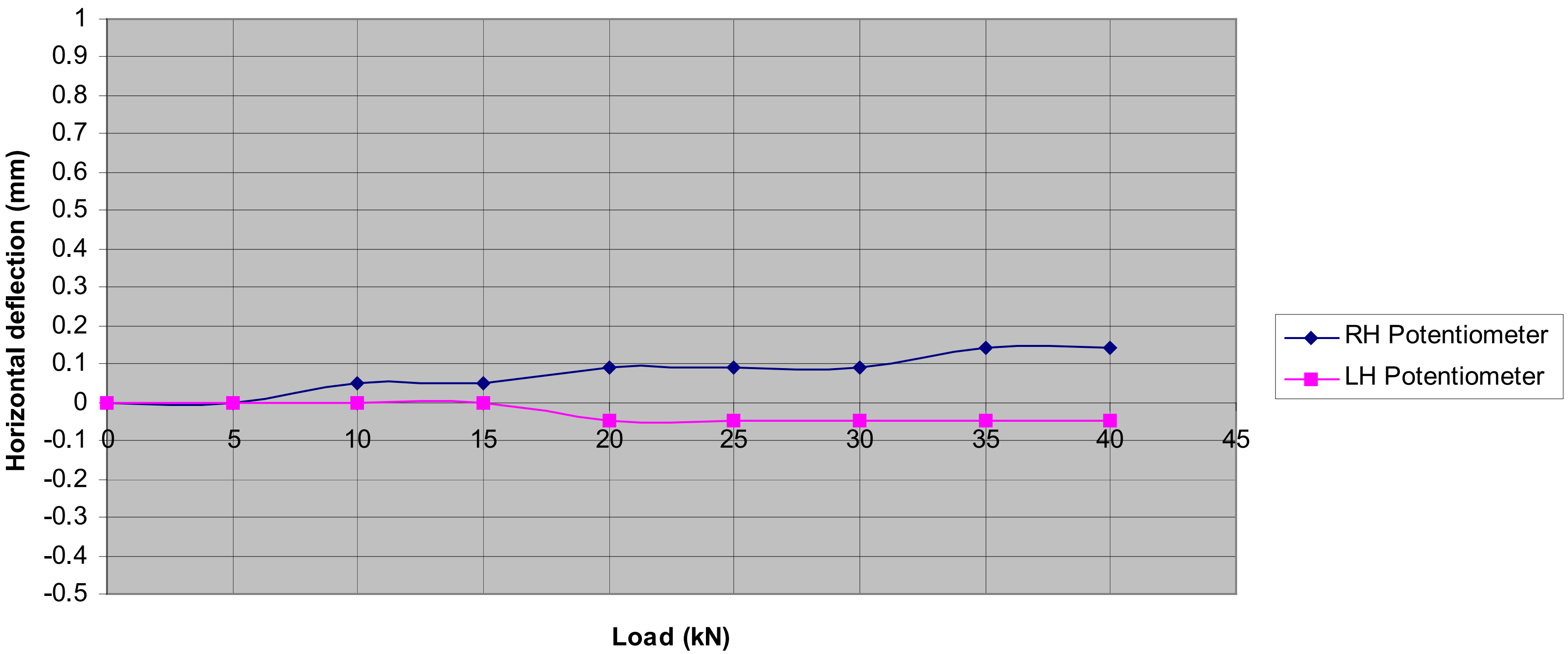

FIG7 LOAD/ DEFLECTION TESTS ON ONE RDT BOX. 600mm opening, horizontal deflections on the centre of the side of the box.

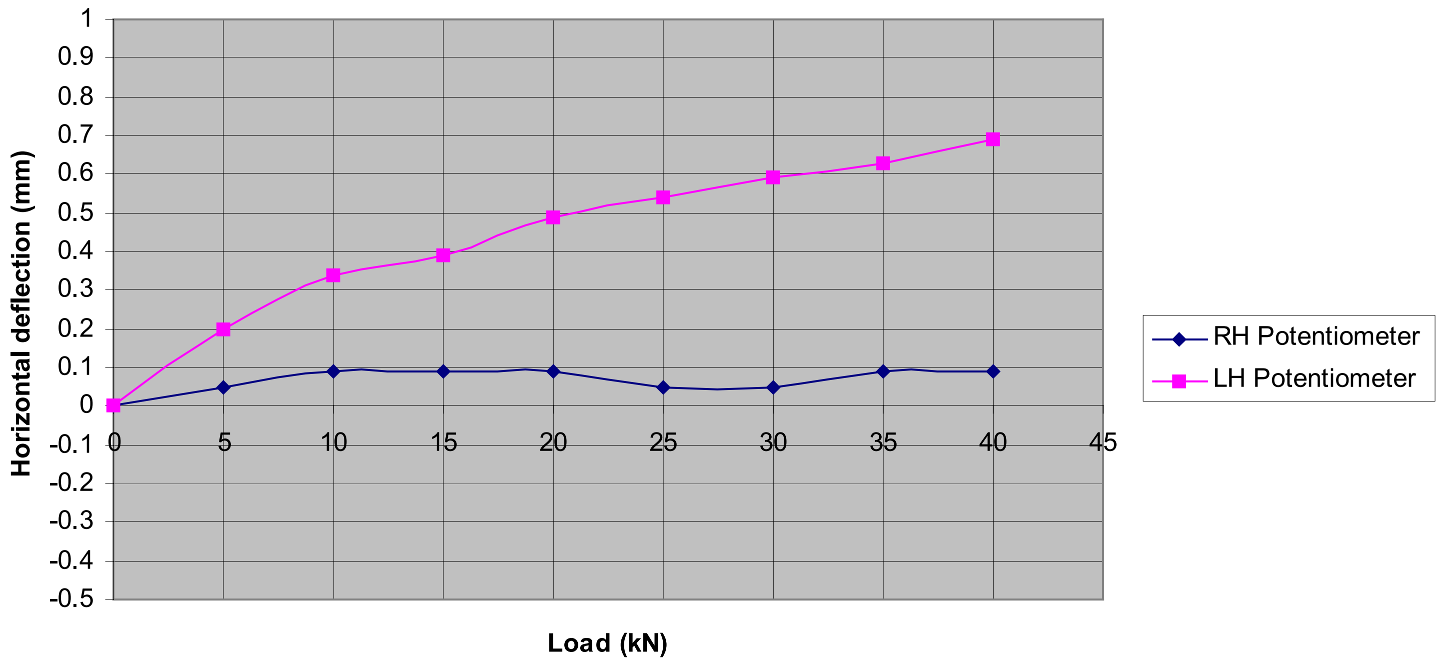

FIG8 LOAD/ DEFLECTION TESTS ON TWO RDT BOXES. 600mm opening, horizontal deflections on the centre of the side of the top box.

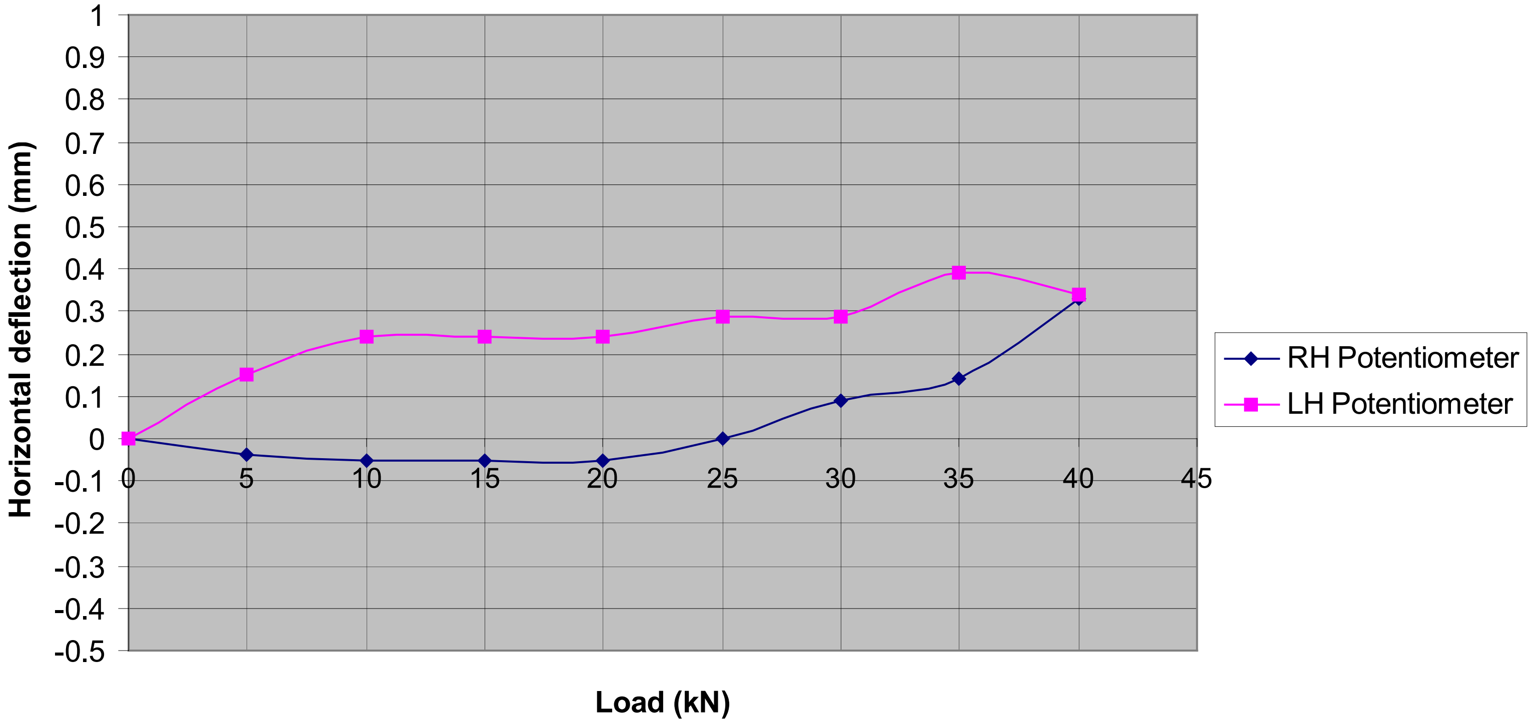

FIG9 LOAD/ DEFLECTION TESTS ON FOUR RDT BOXES. 600mm opening, horizontal deflections on the centre of the side of the top box.

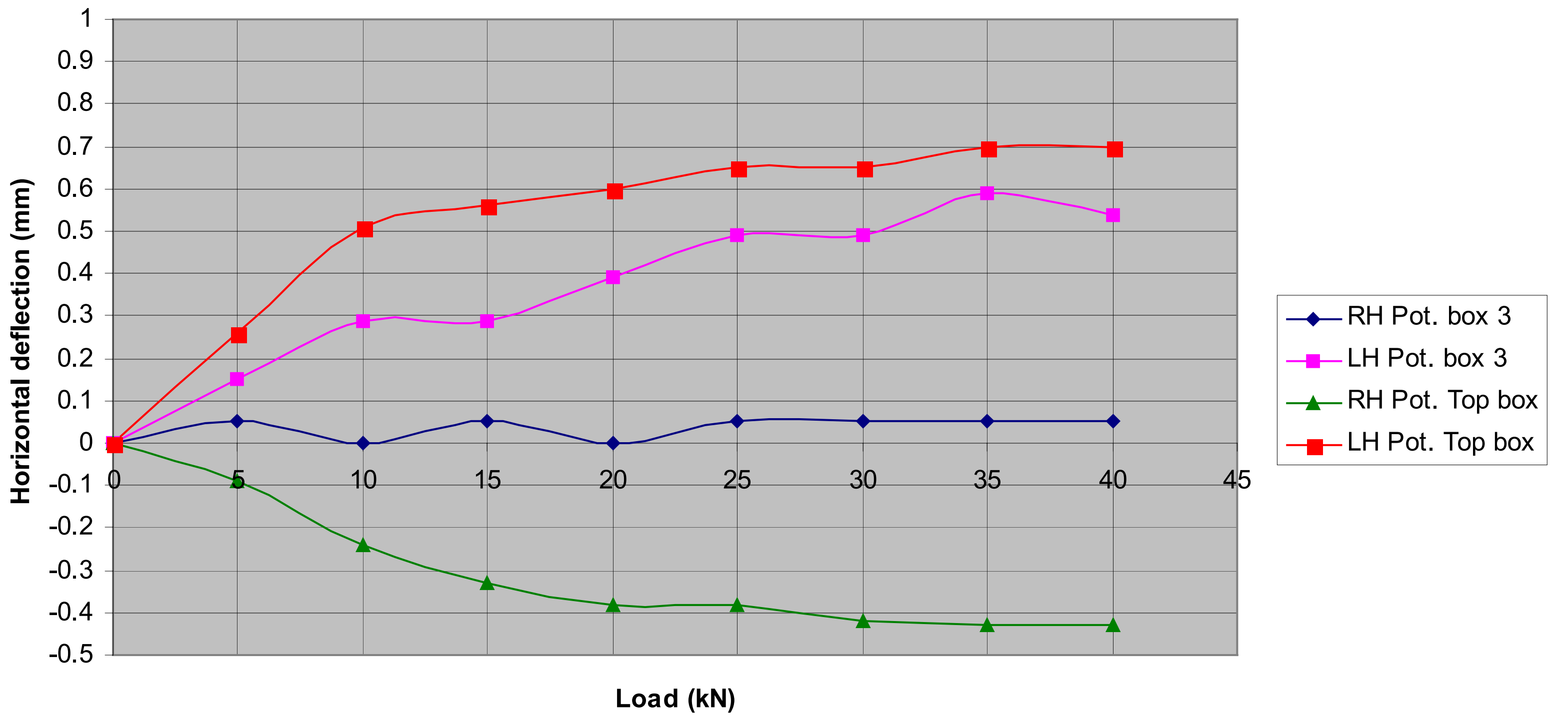

FIG10 LOAD/DEFLECTION TESTS ON SIX RDT BOXES. 600mm opening, horizontal deflections on the centre of the sides of the third and top boxes.

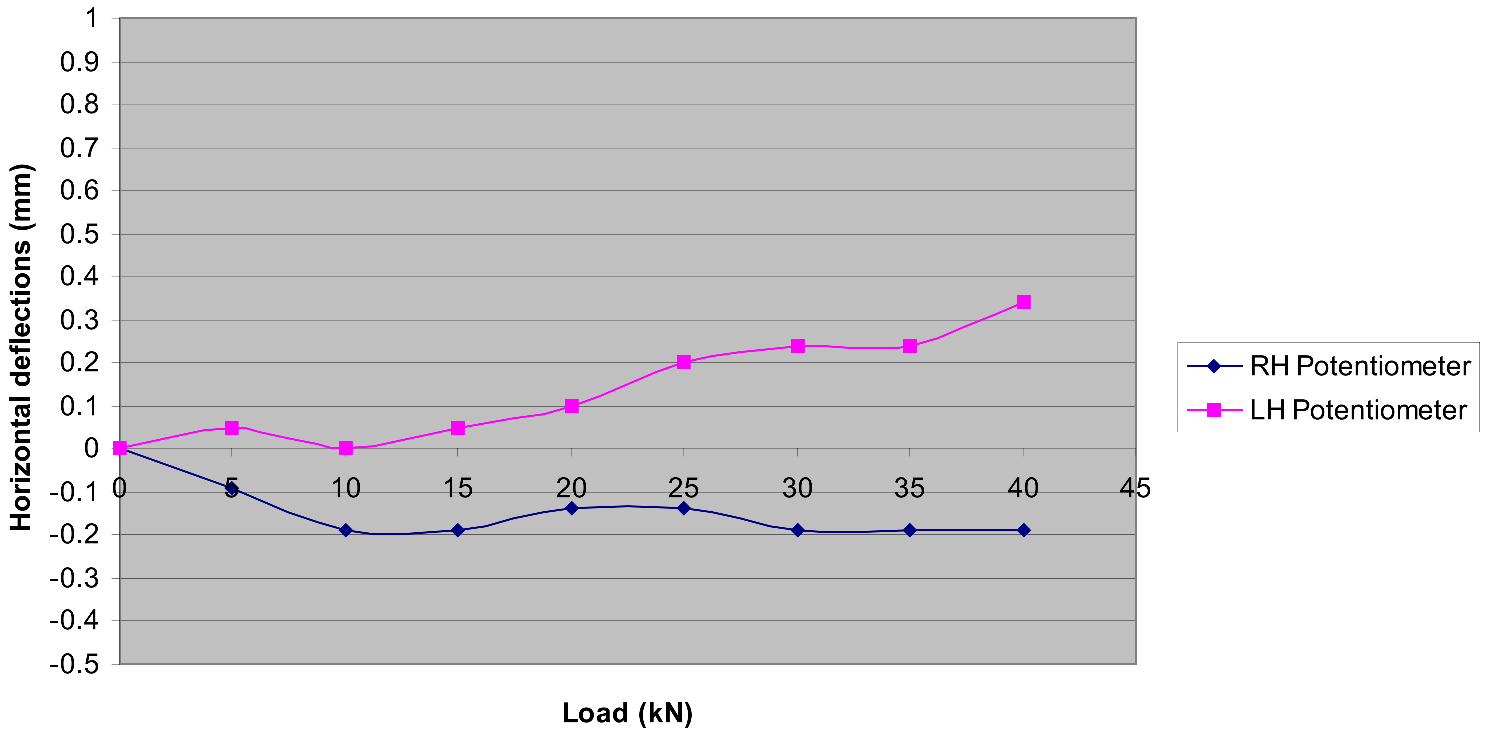

FIG11 LOAD/DEFLECTION TESTS ON SIX RDT BOXES. 600mm opening, horizontal deflections on the centre of the opposite corners of the top box.

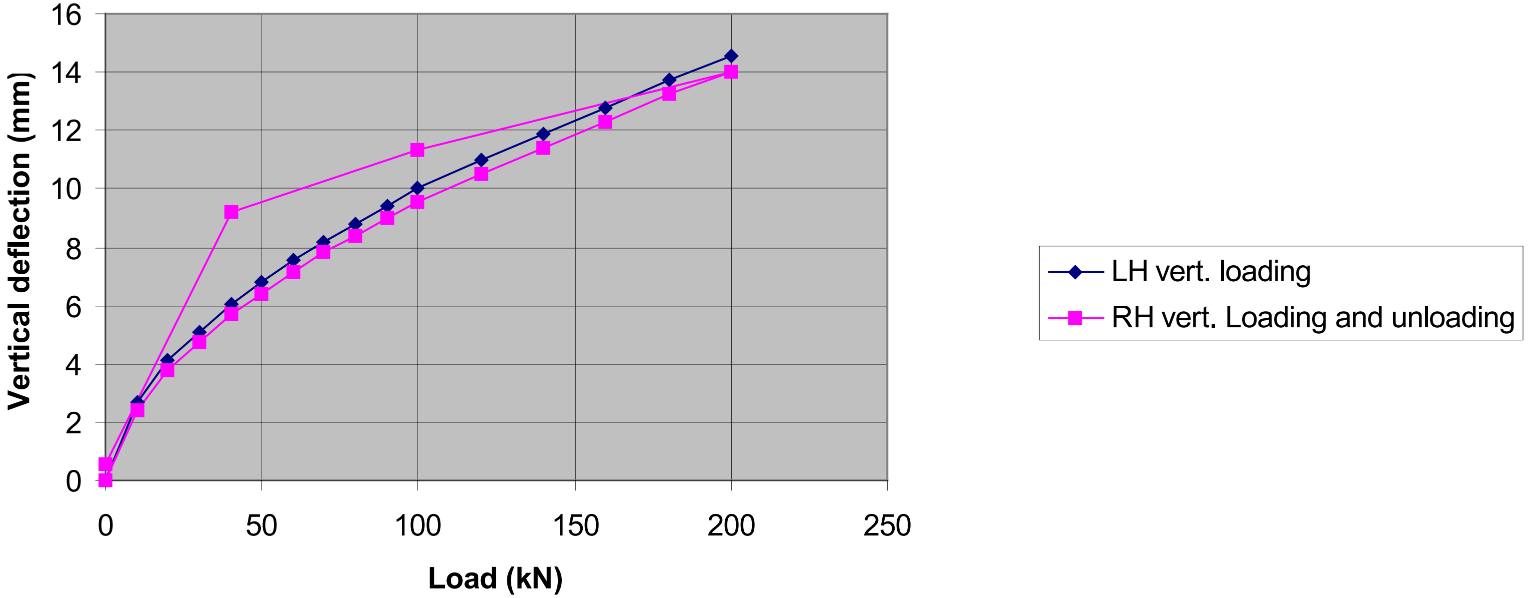

FIG12 LOADING TEST ON AN RDT CHAMBER, 6 boxes, 600mm opening, loading through a 240mm diameter platen on an Interax cover and frame, using dial gauges on the platen

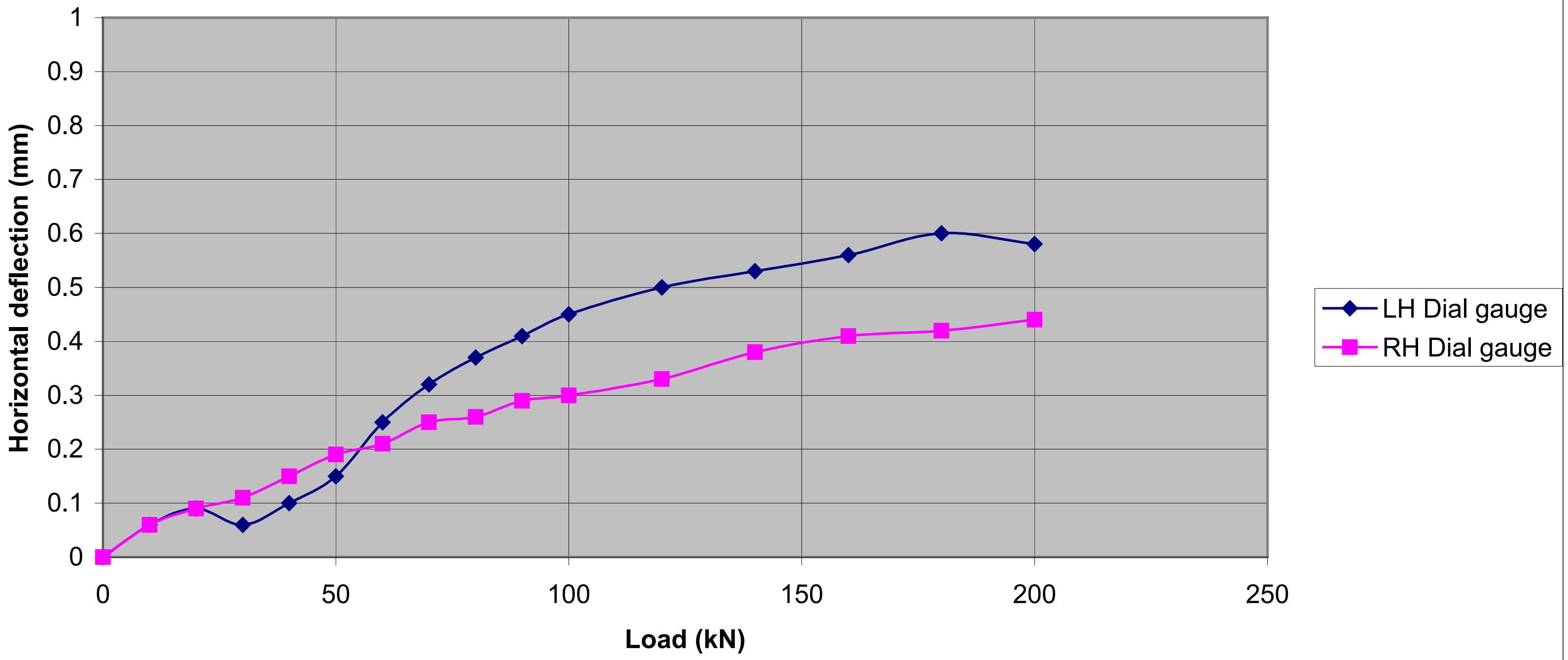

FIG13 LOAD/DEFLECTION TESTS ON RDT CHAMBER BOXES, 600mm opening, horizontal deflection measured at the centre of the side of the top box.

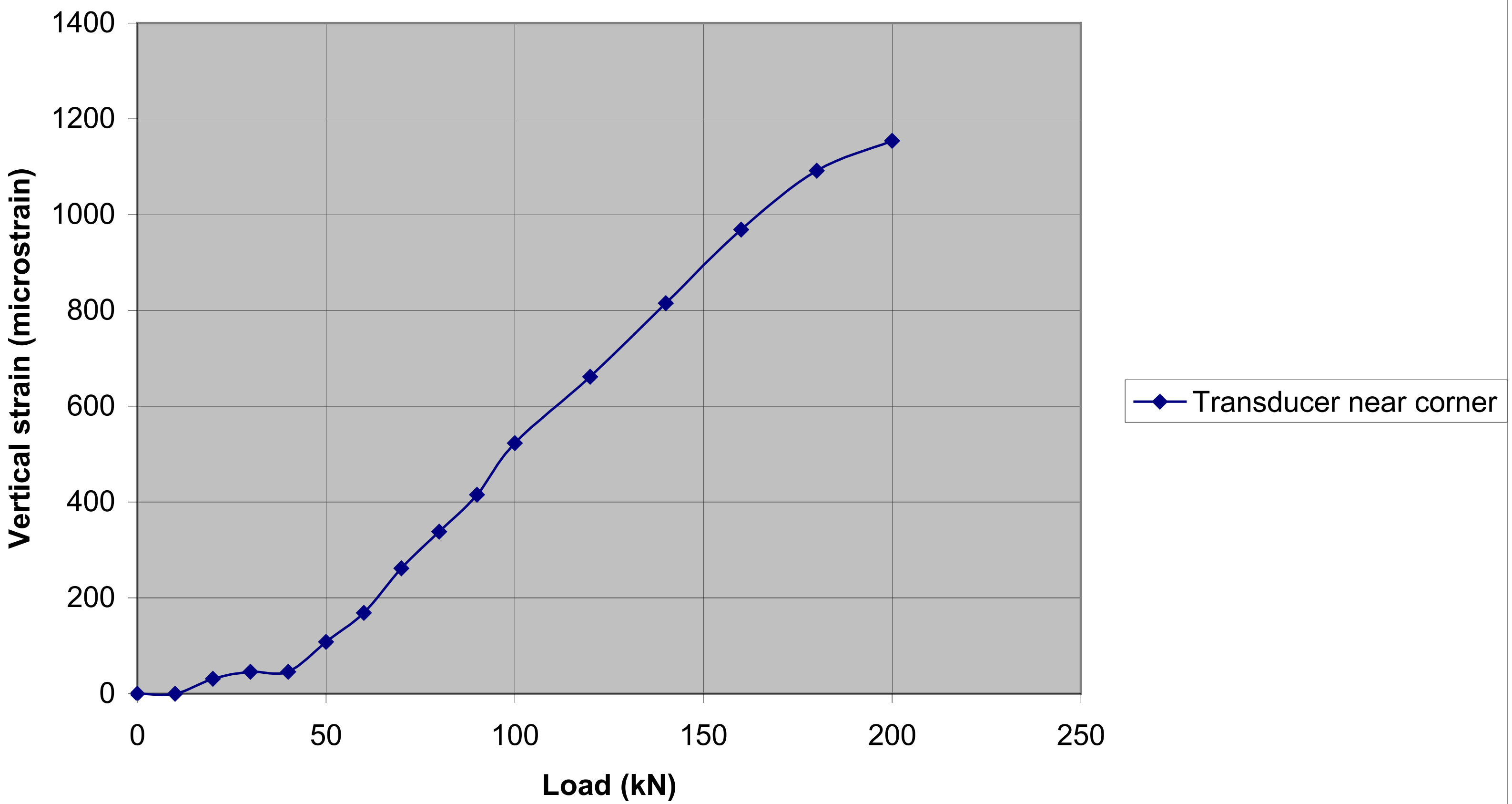

FIG14 LOAD AGAINST VERTICAL STRAIN NEAR THE CORNER OF THE TOP BOX FOR THE SIX BOX CHAMBER