be supported. This example, however, is the only exception, and applies to steel pieces only, whilst the most interesting researches nowadays are made on reinforced concrete, and to support pieces sufficiently to annul the bending moment would introduce a coefficient of friction which would certainly alter the results.

The vertical universal testing machine as manufactured by Olsen and Riehlé, of Philadelphia, can make tensile, compression, and transverse tests of either beams or columns, steel rods or steel cables, and is not very expensive.

The Department has already a vertical universal testing machine of 150,000 pounds capacity, made by Riehlé Bros., of Philadelphia, but we consider that a more powerful machine should be bought, especially if there is room enough for the testing of columns.

One vertical universal testing machine, electrically driven, of 400,000 pounds capacity (for columns and beams), length 12 ft., height 11 ft., breadth 5 ft. 4in., weight 23,000 lbs.	$4,500
4 Johnson's Extensometers for measuring extension or compression in concrete beams, columns and structural members	300
One Ewing Extensometer, for use with standard 8" small diameter specimens	150
One Berry Extensometer	150
One travelling crane (for beams)	1,000
One steel carriage for raising and moving concrete beams	200
Moulds for beams, cylinders, and cubes	250
One overhead traveller	250
One compound generator 25 K.W., capacity 125 volts	500
Small gauges, punches, hammers, micrometers, per cent. gauges, deflectormeters, compressometers, inclinometers, etc.	1,000
One Ransome Mixer, 4 cubic feet capacity, belt driven with hopper on skids	320
Gripping wedges and specimen holders	100
One five horse power motor	300
One void apparatus	100
One furnace, blower, pyrometer, for testing resistivity of material to fire	400
One Brunswick freezing machine capable of giving temperature of —10°	400
One repeated stress machine for testing endurance of steel and other metals under repeated alternate stresses of tension and compression, for testing shafts, etc.	700
One cold bending testing machine	300
One encased abrasion cylinder for building stone	400
One rotating grinder for building stone	400

Machinery Required for Wire Testing.

One wire torsion testing machine	200
One wire twisting testing machine	200
One direct motor driven vertical wire tester; capacity 10,000 lbs., length 4 ft. 6 in. height, 5 ft., breadth 2 ft. 6 in., W. 825, 2 wire extensometer	700 80

Machinery Required for the Testing of Road Material.

One standard abrasion cylinder, designed by L. W. Page	600
Two impact testing machines, as designed by L. W. Page	1,000
One Ball Mill	500
	$15,000

To this should be added about $7,000 for duty, transportation and erection, bringing the total required for the equipment of the physical testing laboratory to $22,000.

The present chemical laboratory would need an additional expenditure of say $3,000, bringing the grand total to $25,000.

During our visit we did not see any arrangement for the testing of reinforced concrete slabs, yet, in no other branch of reinforced concrete construction is there so much disagreement between the different designs. As a proof of this assertion we give below a table taken from an article published some months ago by Louis F. Brayton in the *Engineering News*, giving the weight of steel required in a panel 20 ft. by 20 ft., supporting a live load of 200 lbs. per square foot, calculated by different methods. The working stress of the steel is taken in every case as 16,000 pounds per square inch.

	Thickness of slab.	Pounds of steel in rail.
1 Cantilever	8 inch.	2,189
2 Turneaure and Maurer	12 "	1,391
3 Grashof	8 "	784
4 Mensch	8 "	2,120
5 Turner	8 "	545
6 McMillan	8 "	1,084
7 Brayton	8½ "	1,900

This table indicates a variation of about 400% between the lowest and highest amount of steel under the various methods of computation, and it stands to reason that both extreme methods cannot be right.

If the Cantilever method is best, we stand a chance of seeing the slabs designed under the other methods break down at any moment, and if the Turner is right in its supposition there is an awful quantity of steel being wasted; in any case it is bad engineering practice, and since the theory pure and simple has failed to give a satisfactory analysis of the stresses developed in the slabs, it is time for the laboratory-trained observer to measure accurately the deformation of the slabs under various loads and by the simple transformation of these deformations into stresses to give new basis for future designs.

In a paper read before the National Association of Cement Users, Mr. Arthur Lord, research Fellow in the Engineering Experiment Station of the University of Illinois, describes a test of a flat slab floor in a reinforced concrete building now under construction at Minneapolis, Minn. This test gave valuable information which could not probably have been secured in a laboratory except at a very large expense, but on the other hand the author recognizes the disadvantages arising from the fact that the test could not be carried to destruction. It would seem from the above that the two methods of experimenting will be required before the Engineering profession at large can adopt a fairly uniform method of designing reinforced slabs.

These tests could be made easily in a large room 12 ft. or 14 ft. high, so as to allow one man to stand under the slab to observe the deformation and another to stand over the slab and regulate the loading. This loading could be done by a travelling crane and the load consist of bricks or cement bags or any other easily handled weight.

Cost of Maintenance.

To the present staff of the Cement Testing Laboratory should be added two new assistants. One of these should be well up in chemical analysis and both should be graduates of a recognized school of engineering.

In the Public Roads Bureau at Washington the candidates must be graduates of recognized schools of engineering and are also compelled to pass a stiff examination. In the U. S. Bureau of Standards they are only obliged to pass an examination, but Col. Howard told us that he did not think it possible for a candidate to pass that examination without having attended a school of engineering.

We do not believe that an examination would be necessary unless there were very many candidates, but we think it absolutely necessary that no application should be considered unless the applicant is the holder of a degree from a recognized Canadian Engineering School.

In order to form an estimate of the cost of maintenance of such a laboratory, we give herein the annual report of the Waterton Arsenal for the year 1906.