CEMENT AND CONCRETE ASSOCIATION RESEARCH STATION

OPENING OF THE NEW STRUCTURES LABORATORY

THE opening by the Minister of Works, Mr. George Brown, on May 10, of the recently completed Structures Laboratory of the Cement and Concrete Research Station, Wexham Springs, was an occasion for displaying the whole range of activities of the Station to a large gathering of people representing many sides of industry, science and technology. In introducing the Minister, Sir Francis Meynell, director of the Association, explained that the Cement and Concrete Association was formed in 1935 by the Portland cement industry in the United Kingdom to give technical service to cement users, and the Association obtains its funds from a levy on all cement delivered in Great Britain. Its work includes research, technical advice, publications and training in concrete technology. The new Laboratory is the latest addition to the resources of the Association.

Before opening the Laboratory, Mr. Brown said that he had inspected the Research Station and had been particularly impressed with the work that had been done on the development of surface finishes for concrete. He was glad to know that it is so easily possible to make concrete having an attractive appearance. He regretted that the research programme did not include work on the uniformity of cement and hoped that this might be remedied in the future. He also spoke of the importance he attaches to the proper training of engineers and others engaged in concrete construction and expressed the hope that the training courses run by the Association will be further developed and extended. In thanking the Minister, Mr. A. M. C. Jenour, chairman of the executive committee of the Association, emphasized the degree of co-operation in research that exists between the Association and the various government, academic and professional institutions interested in construction techniques.

The Research and Development Division of the Cement and Concrete Association at Wexham Springs was set up in 1947 in what was formerly a private estate, and is organized into five sections. The Physics and Chemistry Section studies fundamental problems of the behaviour of cement and concrete and is responsible for the development of physical and electrical apparatus required by other sections. The engineering properties of concrete are the main concern of the Concrete and Concrete Materials Section, which pays particular attention to the design of mixes and the problems involved in quality control. The Structures Section studies problems met in designing concrete structures and particularly those new types of structure now being increasingly used in building construction. Certain special problems involved in the use of concrete are dealt with in the Engineering Section, and this Section is at present engaged in work on steam curing and vibration. The Development Section studies works processes with particular emphasis on new methods; its work is directed mainly to the problems of improving the surface appearance of concrete, the development of prestressed concrete roads and of textured surfaces for roads.

A number of outbuildings, originally constructed for more domestic purposes, have been adapted for use as laboratories at the Station; but the Structures Laboratory opened by the Minister of Works is the first of the buildings specially designed for the purposes of research. It is 100 ft. long, 30 ft. wide and 26 ft. high; at one end there is a smaller laboratory, 30 ft. by 30 ft. and 14 ft. 3 in. high, which will be used for making concrete and for research on precast concrete; there are also two small blocks containing offices, stores and lavatories. The main building is constructed with a frame composed of reinforced concrete columns and prestressed concrete main beams supporting the roof; the walls are in brick and concrete block construction with clerestory windows in precast concrete frames. The exterior is finished with a variety of treatments including precast concrete slabs, textured rendering and asbestos cement sheeting.

Special apparatus has been developed for making tests on large structural elements. It was felt that the most economical method of carrying out a wide range of tests of this nature was to construct a universal testing machine capable of being arranged in as many ways as possible. The testing equipment consists essentially of a base plate and an adjustable frame on which hydraulic jacks can be mounted. The base plate is formed by a part of the laboratory floor; it is 40 ft. by 27 ft. in plan and 2 ft. 6 in. thick, reinforced with 1-in. bars at 6-in. centres in both directions at the bottom and 1-in. bars at 21-in. centres at the top. Cast into the floor are 263 screw anchor sockets arranged in an equilateral triangular pattern, and each capable of resisting a pull of 5 tons. Ducts have been provided within the floor, through which prestressing cables may be passed if it is required to be strengthened.

The adjustable frame consists of a system of steel columns and beams in which there have been drilled a number of hole patterns allowing it to be put together in a variety of ways. The frame can be erected to enclose an experimental structure, and with slight adjustments it can be used for direct compression tests on columns or for racking tests on frames. By erecting two separate frames and fixing a cross-member on the experimental specimen to take the thrust of two jacks, torsion tests can be made. It is also possible to make tests on large beams by placing them sideways on the floor and loading them by jacks acting sideways also anchored to the floor.

The jacks are operated by a hydraulic system, fed by an axial plunger pump with a capacity of 938 cu. in. per min. at pressures up to 4,000 lb. per sq. in. driven by a 10 h.p. motor. The straining-rates of the jacks can be adjusted by metering-valves which enable a predetermined amount of the flow to be discharged to exhaust. The equipment has been designed to operate six double-acting jacks, each with an independent pressure-reducing valve. Infinite variation of the force applied by the jack is allowed by the provision of a small back-pressure. The jacks are designed to apply a compressive force of up to 50 tons and a tensile force of up to 21 tons. The line pressure is used for giving an indication of the jack force, but for accurate measurement pressure capsules are inserted between the jack and the specimen.

For convenience of operation, all the controls and gauges have been collected together into one mobile unit. Oil at high pressure is supplied through flexible tubes to the control unit, where it is metered and reduced in pressure and distributed through a further set of flexible tubes to the six jacks inserted between the test frame and the specimen. Although the hydraulic jacks will be used in most experimental work, loads can also be applied by means of dead weights or by air bags acting between the specimen and the reaction framework. For strain measurement on test specimens, it is intended to use electrical resistance methods, acoustic gauges and mechanical dial-gauge strain indicators.

The first work to be undertaken in the new Laboratory will consist of experiments on inter-connected concrete beams prestressed longitudinally and transversely, the aim of which is to compare the performance of the structure in the elastic range with the predictions of theory, and to observe the form of the redistribution of load among the beams after cracking.

The main lines of work of the other sections of the Research Station have already been mentioned; space does not allow these to be fully described, but the following items are of general interest. The Physics and Chemistry Section is working on a semi-micro colorimetric method, using a 'Spekker' absorptiometer, for analysing silicates and other related compounds found in the materials from which concrete is made; this allows the time required for the analysis of cement, for example, to be reduced to one-third or one-quarter of that required when ordinary methods are used.

The section is also engaged on a study of efflorescence on concrete. This phenomenon arises from the leaching out to the surface of lime liberated during the hardening of cement, and little is known of the factors that influence its appearance in any particular circumstances. The work has shown that the physical structure of the concrete and the texture of the surface have considerable effect, and concrete of a wide range of compositions and surface textures is being prepared to determine the conditions in which efflorescence does or does not appear. Apparatus has also been designed for locating and measuring the position of reinforcement in hardened concrete and for measuring the elasticity of concrete by determining the velocity of sound. A study is also being made of surface-active agents used for improving the workability and durability of concrete, while in the future it is hoped to make a fundamental study of the micro-structure of hardened concrete.

In the Concrete and Concrete Materials Section research is being carried out on the quantitative measurement of the shape and surface texture of aggregates by determining the resistance to the flow of a fluid through a bed of the particles, and an attempt is being made to relate the shape and texture with the workability of concrete made from similar aggregates. In the work devoted to aggregates a study is also being made of their absorption characteristics, of the methods of determining their moisture content and of the principles governing the control of moisture content of aggregates on works sites. The Section has completed the collection of data on the mix proportions required to produce concrete of predetermined characteristics with aggregates of $\frac{3}{8}$-in. maximum size, and an examination is now in progress of the factors affecting the design of mixes of very high strength.

The work on steam-curing done by the Engineering Section has made it possible to correlate and reconcile the apparently conflicting results hitherto obtained elsewhere and to gain some insight into the underlying principles involved. A considerable amount of development work is being done on the surface treatment of concrete. This has been concentrated mainly on the use of precast concrete slabs to be used as cladding for buildings or for permanent shuttering, but some work on the surface treatment of *in situ* concrete and external renderings has been done. Emphasis is given to the production of surfaces characteristic of concrete by exposing the aggregate in a number of different ways, and a wide range of coloured and textured finishes has been produced. Tests are being made on the weathering qualities of these slabs both in rural and industrial areas. Investigations are also being made on the production of similar textured surfaces for roads and paved areas, and on the development of prestressing for concrete roads in order to overcome the need for joints and to allow comparatively long lengths of slabs to be laid continuously. It is hoped in this way to save cost and improve the appearance and riding quality. The first experiments on prestressing concrete roads in Great Britain were made at Wexham Springs in 1950 with a simple method of prestressing developed by the staff of the Association.

In co-operation with the Research Committee of the Cast Stone and Cast Concrete Products Industry, work has just begun on a study of problems involved in the compaction of concrete by vibration, in general, and the use of vibration in making precast concrete products, in particular. The work is still in its early stages, but it is planned to test a whole range of commercial vibrating equipment which will also be used to form a permanent exhibition at Wexham Springs.

In 1950 the Association set up a training centre close to the Research Station, and five-day residential courses are held on such subjects as prestressed concrete, design of concrete mixes, quality control of concrete, farm buildings, roads and new developments in technique. Lectures and demonstrations are given, in the main, by members of the research staff; but in some instances outside specialists lecture on their own particular subjects. During the past seventeen months more than five hundred students have attended these courses.

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

THE foundation stone of the last of the series of eleven national laboratories being set up by the Council of Scientific and Industrial Research of India was laid at Roorkee by the Hon. Mr. Sri Prakasa, Minister for Natural Resources and Scientific Research, on February 10. Roorkee has long been well known as an engineering centre. The Thomason Civil Engineering College at Roorkee was a pioneer institution in India, and last year it became the University of Roorkee; now it is accommodating the new Research Institute until such time as the Institute's own building is ready.

Building research was originally conceived as one of the nine divisions of the National Physical Laboratory recently set up at Delhi; but the prevailing