and social studies undertook further education or training and 38 per cent entered employment; 55·7 per cent of the women undertook further education or training compared with 39·4 per cent of the men. However, while 13·0 per cent of men undertook research or further academic study, only 7·0 per cent of the women did so; on the other hand, 34·5 per cent of women undertook teacher training compared with 17·9 per cent of the men.

For pure and applied science, taking men and women together, 36·9 per cent undertook further education or training and 50·9 per cent entered employment; for the men, the corresponding figures are 50·3 per cent and 39·3 per cent in pure science and 17·5 per cent and 66·1 per cent in applied science, and for women in pure and applied science, 41·6 per cent and 50·2 per cent. For graduates in both arts and social studies and in pure and applied science, only 2·2 per cent entered employment overseas, but for men this figure was 2·8 per cent for applied science and 1·9 per cent for pure science. Of science graduates who entered employment within the United Kingdom, 9·3 per cent of the men entered the public service (other than education), 19·7 per cent education (in schools, colleges and universities without postgraduate training first) and 66·3 per cent industry and commerce; for graduates in applied science the corresponding figures are 10·4, 2·8 and 84·9 per cent, respectively; and for women graduates in pure and applied science, 22·9, 43·3 and 29·3 per cent, respectively. For graduates in arts and social studies, 13·9 per cent of the men entered the public service, 19·9 per cent education, and 46·5 per cent industry and commerce; for women the corresponding figures are 21·8, 48·7 and 17·2 per cent, respectively.

The report shows that of every 100 men graduating in pure science, 31 undertake research or further academic study and 14 undertake teacher training; in applied science these figures are 16 and 1, respectively, and for women in pure and applied science 13 and 25, respectively. Over the past five years, the proportion of graduates in pure and applied science undertaking teacher training has risen slightly from 9 to 11 per cent, and of those undertaking research or further academic study from 22 to 23 per cent, but the proportion gaining employment at home in education or gaining employment overseas has remained unchanged at 7 per cent and 2 per cent, respectively.

## SULPHATE EXPANSION IN CONCRETE: A NEW HYPOTHESIS

THE phenomenon of sulphate expansion in cement paste or concrete is a well-known hazard to be reckoned with in building and highway construction by civil engineers and others concerned. For example, in highly gypsiferous clays, such as obtain at certain horizons and places in the London Clay, the use of ordinary Portland cement concrete is avoided in favour of sulphate-resisting or aluminous cements. The causes of sulphate attack in concrete have received international attention over the years, but even to-day the precise mechanism of the reaction is still an open question.

Sulphate expansion means an increase in volume of cement paste or concrete occurring as a result of chemical reaction between the hydration products of cement and sulphate-bearing solutions with which it may come in contact. T. Thorvaldson has stated (1954): "While the formation of crystals of sulpho-aluminate and gypsum in Portland cement mortar during disintegration in sulphate solutions is well established, many observations throw doubt on the assumption that physical forces of crystallization are the primary cause of expansion and loss in strength". Previous theories have assumed that the chief cause of expansion is the formation of ettringite ($3CaO.Al2O_3.3CaSO_4.31H_2O$) (Larsen), from alumina-bearing compounds present in cements.

S. Chatterji and J. W. Jeffery have put forward a new theory which suggests that sulphate expansion is caused by solid-state conversion of calcium aluminate hydrate to calcium aluminate monosulphate and "that this expansion may or may not be accommodated depending on the concentration of lime in the liquid phase" (*Magazine of Concrete Research*, 15, No. 44; July 1963).

S. Chatterji and A. Grudemo have investigated paste hydration of calcium aluminate gypsum mixtures with and without calcium hydroxide (paper in course of publication). "The pastes, of water/cement ratio 0·6, were contained in brittle plastic vials. In the case of the pastes containing $Ca(OH)_2$, the vials which remained unused after 14 days had cracked by expansion before 3 months, while the three without $Ca(OH)_2$ remained intact. The course of the reaction was followed by X-ray diffraction and electron-optical techniques. It was found that the initial sulphate-bearing compound was ettringite, but the final one was calcium aluminate monosulphate ($C_3A.CaSO_4.xH_2O$) in both cases; the change from ettringite to monosulphate occurred between 14 days and 3 months, the period during which the vials cracked" (see p. 463 of this issue).

The basis of this hypothesis is briefly explained in Chatterji and Jeffery's paper, but, as they rightly point out, the theory on which their explanations rest is far from being established. If it is confirmed by further work, then the next stage is to establish the mechanism of disruption. The hope is expressed that by putting forward this hypothesis now, further research on this subject will be stimulated.

H. B. MILNER

## INTER-INDUSTRIAL OCEANOGRAPHIC RESEARCH IN THE UNITED STATES

THOUGH no exact figures are availablo, it is reasonably certain that since the war, and probably for some years before it, the United States has spent more on oceanographic research than the rest of the Western world put together. The Federal Government alone is spending 124 million dollars per annum at the present time, and plans to treble this over the next ten years. Much of this money is spent on buying or developing equipment, and a number of small firms have sprung up in the past decade to satisfy this requirement. However, the sums involved are now sufficient to interest big business. One Californian oceanographer who was visiting Great Britain last year pointed out that his firm had set up an Oceanographic Systems Group with an initial budget of 1 million dollars, and had told the Group leader that when he had spent this he should ask for more. At the time of the first conference, commercial firms in California alone employed 32 professionally trained oceanographers (mostly physical oceanographers), quite apart from the supporting staff of engineers. For comparison, the whole of Western Europe can muster about 130 physical oceanographers in all types of employment.