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SEARCH TO A NEW, RAPID AND RELIABLE TEST METHOD, WITH A VIEW TO EVALUATE THE DAMAGE RISK IN CONCRETE, DUE TO ALKALI-AGGREGATE REACTION

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1. INTRODUCTION

Most of test methods for Alkali-Aggregate Reaction which are performed up to now, are based on the over-time principle measurement of the linear lengthening of prismatics mortars bars subjected to various conditions of temperature and hygrometry.

These different norms used in many countries enable to get some idea on the reactivity of the couple cement-aggregate tested.

However, few investigations on the study of the internal strength factor generated by these reactions, which have been made.

Therefore, it seems advisable for us to evidence this phenomenom.

2. TECHNOLOGY

In order to measure the stresses generated by an expansion, we have opted for a triaxial system.

The conventional triaxial test consists in subjecting a material to a stress field up to breaking.

The following three phenomena are observed :

$\sigma 1$: Total axial stress ($\sigma 1 = \sigma 3 + (\sigma 1 - \sigma 3)$)
$\sigma 3$: Hydrostatic stress (containment)
$\sigma 1 - \sigma 3$: Axial deflecting phenomenom

In a first time, an isotropic stress $\sigma 3$ is applied to the material (fig. 1.a.), then the axial deflecting phenomenom $\sigma 1 - \sigma 3$ is increased which yields the ellipsoid stress (fig. 1.b.).

The deflecting-deformation graph is recorded during all the test. This graph allows to obtain the principal stress σ1 applied to the material at the breaking moment.

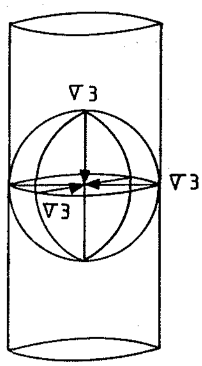

Fig. 1.a. Isotropic stress σ3

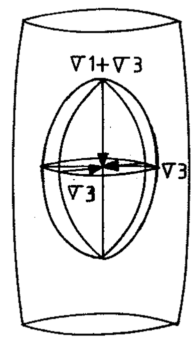

Fig. 1.b. Ellipsoid stress

The problem was consisting in the adaptation of this device to measure directly the stresses with a constant volume.

3. PRINCIPLE OF THE METHOD

The principle of the test is based on the following hypothesis :

"If during an Alkali-Aggregate Reaction an expansion occurs due to a neoformation product in the concrete, it means that the product generates an inflating thrust.

If the material deformation can be stopped by maintaining a constant volume, then we can know the preśsure transmitted by the neoformed product."

4. DEVICE

The device used (fig. 2. & fig. 5.) allows to lock the test specimen according to the axis σ1 and thus to prevent any axial deformation.

A liquid of known compressibility allows to maintain the desired constant volume for the test specimen containment (σ3). This liquid is also used to transmit the pressure to the sensor.

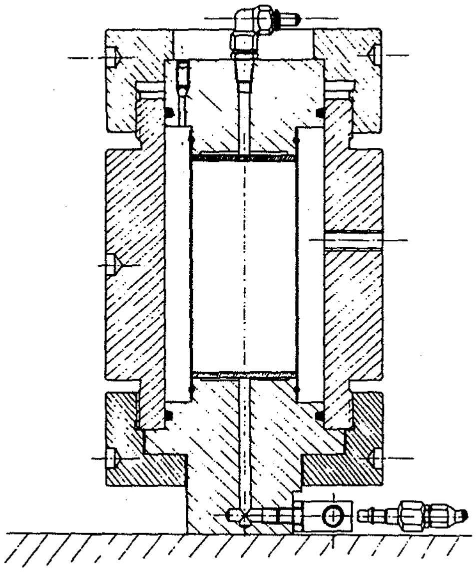

Fig. 2. Triaxial device

5. MEASUREMENT PRINCIPLE

The axial stress $\nabla 1$ applied to the test specimen locked is uniform (fig. 3.a.). When the test specimen is the centre of a reaction, the liquid stops the deformation by maintaining a constant volume.

The stress deflecting phenomenom becomes in that case $\nabla 3 - \nabla 1$ (fig. 3.b.), and the measurement gives directly the hydrostatic stress $\nabla 3$.

6. PREPARATION OF TEST SPECIMENS

The test specimen is prepared in accordance with the requirements of the Standard Test Method C 227-81, except for the following specifications :

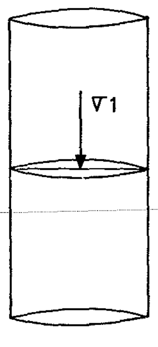

Fig. 3.a. Uniform stress $\nabla 1$

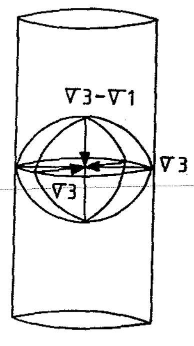

Fig. 3.b. Stress deflecting phenomenom

6.1 Test Specimen Dimensions

The test specimen form is cylindrical (fig. 6.). The cylinder dimensions are :

- Diameter : ∅ 60 mm (2.36 in)
- Height : 120 mm (4.72 in)

6.2 Proportioning of Components

The proportioning of components is corrected in terms of specific gravity of each constituent, in order to obtain a constant porosity.

6.3 Alkali Cement Content

If the alkali cement content, calculated as Na_2O equivalent, is lower than 1.25 % by mass of cement, a proportional addition of NaOH is made in the mix water [1] .

7. STORAGE OF TEST SPECIMENS

7.1 Initial Storage

After making, the mold is placed in a moist cabinet at a temperature of 20°C ± 1°C (68°F ± 1.8°F) for 24 hr ± 1 hr.

7.2 Subsequent Storage

7.2.1 Cure period After removing, the test specimen is placed in an other moist cabinet at a temperature of 40°C ± 2°C (104°F ± 3.6°F) for 7 days.

7.2.2 Test period After the cure, the test specimen is placed in the triaxial device for 28 days in the moisture and at a temperature of 40°C ± 0.1°C (104°F ± 0.18°F).

8. RESULTS

The first specimens tested give us the results mentioned in Figure 4.

Inflating thrusts approximately of 0.8 MPa with Pyrex specimens and other thrusts of 1.0 MPa with Canadian Spratt specimens are obtained.

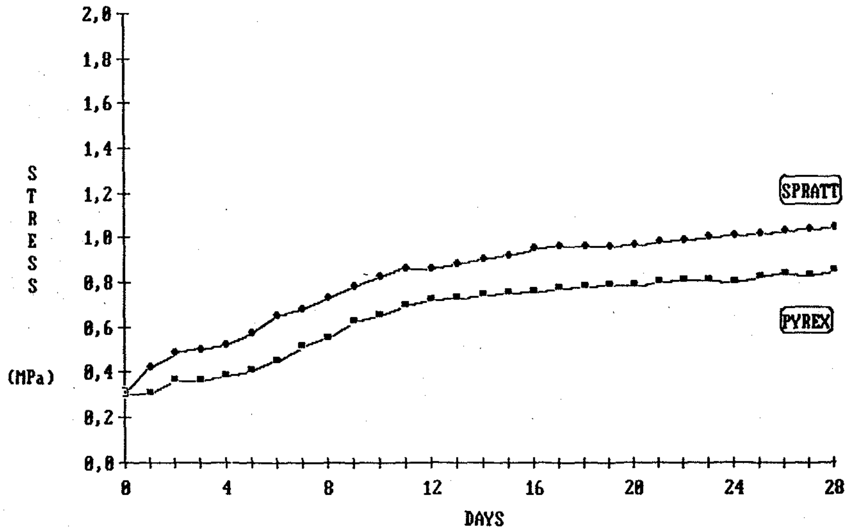

Fig. 4. Inflating thrust versus time graph obtained for Pyrex and Canadian Spratt test specimens.

Modifications and final adjustements of the device are currently carried out to eliminate some interference elements. In addition, new tests with different materials will be performed. These future results should allow to classify the different aggregates tested according to their rectivity.

REFERENCES

[1] ACNOR CAN3-A23.1-M77, Appendix B, p.26

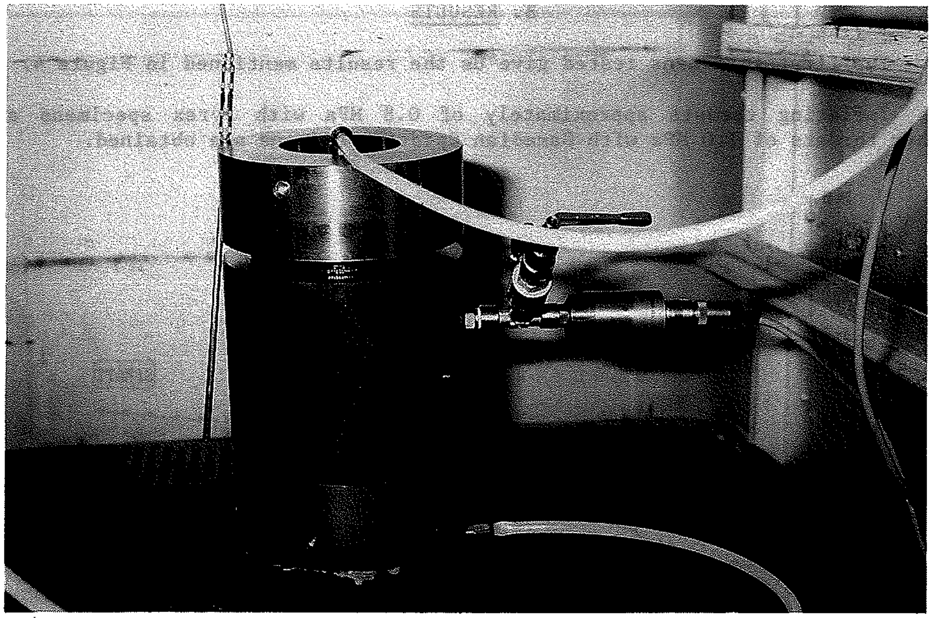

Fig. 5. Triaxial device

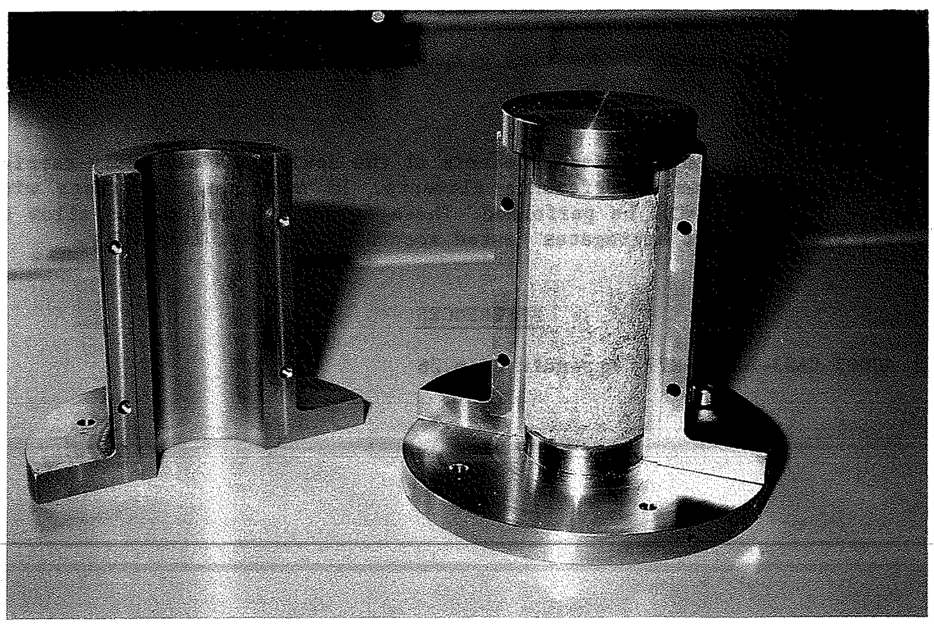

Fig. 6. Test specimen and mold