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INTENSIVE COMPACTION TESTER

DEVICE FOR TESTING THE COMPACTABILITY OF NO-SLUMP CONCRETE

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SYNOPSIS

A new method and device for testing the compactability of concrete is introduced. The testing device compacts the concrete sample very effectively and reports the development of the density during compaction. The applications of this method are in quality control and research of no-slump concrete.

Keywords: Testing method, testing device, no slump concrete, compactability

1. ON THE PROPERTIES OF NO-SLUMP CONCRETES

Many products are manufactured of no-slump concrete by slipforming or other methods of mechanical moulding or by rolling. As a rule the water-cement ratio of fresh concrete is between 0.25 and 0.4. The use of such concrete is advantageous because:

- The mould can be stripped immediately after compaction. The compacted concrete is, even when fresh, so firm that the unit retains its shape.
- The concrete will achieve high strength, because no excess water remains in the set concrete. Almost all the water used will be chemically fixed to the cement.

As a consequence of the small amount of water used compaction is more difficult. In addition, it is difficult to keep the working properties of the concrete uniform because in practice:

- It is difficult to measure the water content in the aggregate continuously and, accordingly, to dispense the water into the concrete accurately.

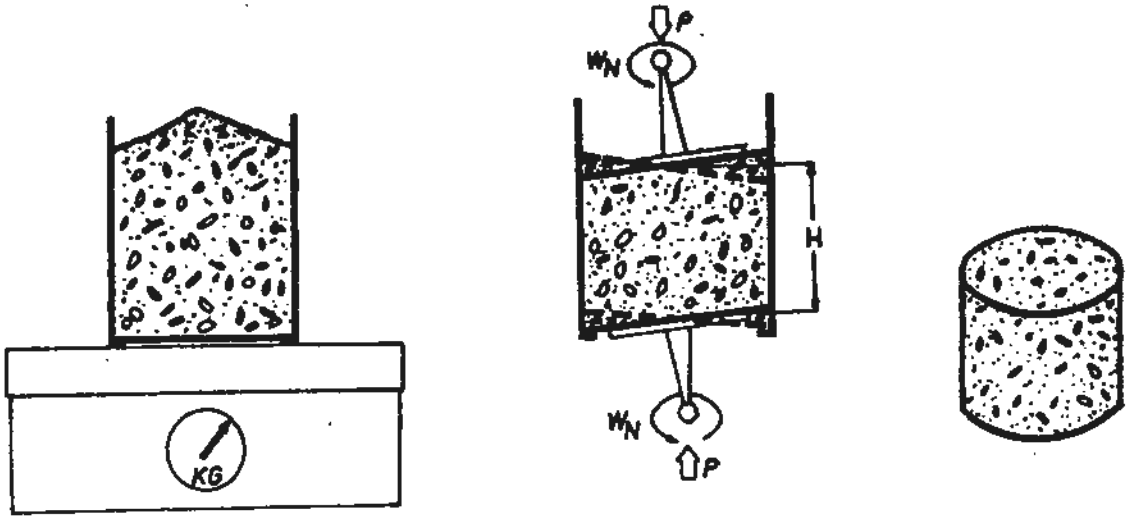
It is difficult or impossible to measure the working properties of fresh no-slump concrete. The methods used measure instead other properties, such as the consistency of the fresh concrete or the strength of poorly compacted test specimens.

A new testing device has been developed that measures the compactability of no-slump concrete. Its application in production quality control began in 1986.

2. WORKING PRINCIPLE OF THE TESTING DEVICE

The device compacts fresh concrete with the "Intensive Compacting" method in which the concrete is compacted slowly, mechanically by means of an accurate, repeated working motion.

When the work cylinder, containing the concrete sample, is placed into the measuring device, the apparatus starts to compress the sample from above and below. Note that the cylinder top and the cylinder bottom are parallel and not perpendicular, but slightly inclined to the cylinder wall. The testing device changes the direction of inclination of the cylinder end plates through eccentric rotation (W_n in figure 1), and the concrete sample is compacted under pressure (force P in fig. 1). This slow and controlled oscillating movement makes it possible to observe and measure the compaction (as calculated by the use of H in fig. 1) accurately.



a) Weighing of the concrete sample in the work cylinder.

b) Compaction of the concrete sample between the cylinder plates.

c) Compacted sample

Fig. 1 Intensive compaction testing procedure

The device monitors continuously the compaction of the concrete, calculates and reports the densities of the sample at the end of the test.

Although the test apparatus mechanism is unique, the compaction conditions and properties are very similar to those that occur in practice by the casting of no-slump concrete by extruder machines. Therefore, the same factors affect the test results as in actual production. The most important factors are variations in the water amount contained in the concrete, the quality of aggregates and admixtures used. The amount and grade of the cement has, of course, also some effect on the compaction properties.

INTENSIVE
COMPACTING
TESTER

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TEST NR 1
SAMPLE AGE 11 MIN
SAMPLE WEIGHT 901 G

DENSITY 10= 2294
DENSITY 20= 2364
DENSITY 40= 2425
DENSITY 80= 2475
DENSITY 160= -
DENSITY 320= -

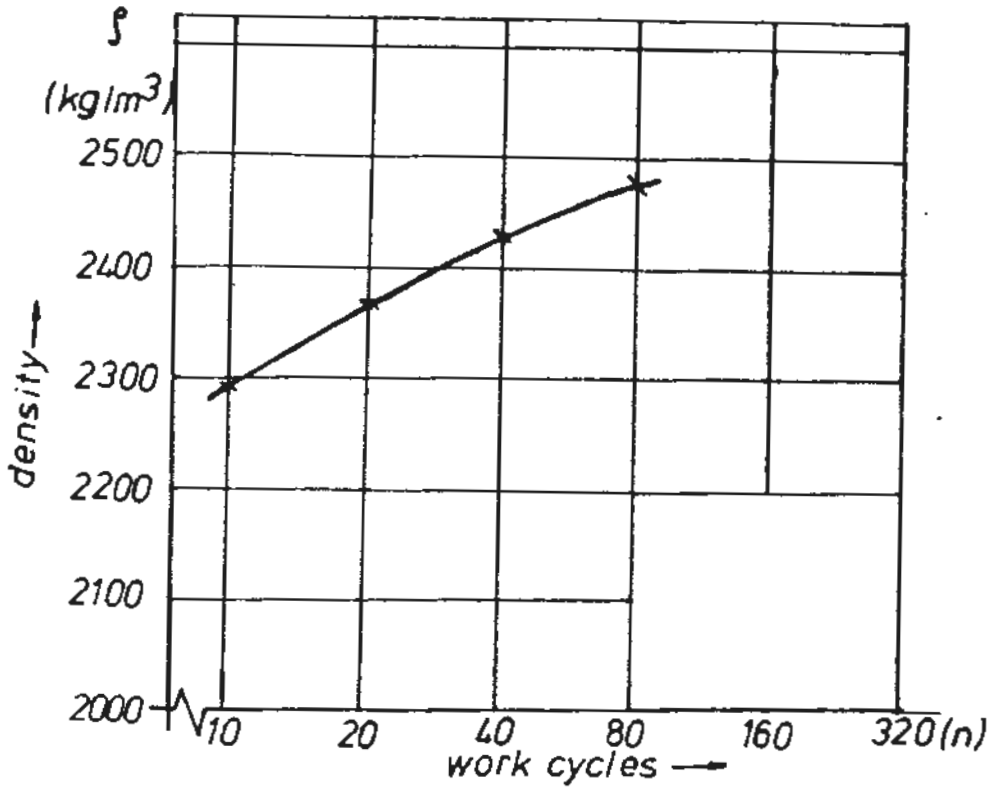

Fig. 2 Test report and compacting diagram

The method used by the individual performing the measurements, in contrast, has no effect on the results because the device compacts the sample automatically, according to the instructions given.

3. INTERPRETATION OF THE RESULTS

In figure 2 is shown an example of a test report and a diagram describing the compactability of a sample.

In most cases when monitoring product quality, it is sufficient if the density of the sample is examined after 80 work cycles. This is called compacting index = IC80 index, and is comparable with experiences gained in earlier production. In the above example IC80 = 2475. When necessary, the water ratio must be changed.

Fresh concrete suitable for production is, of course, not always similar. The value of the compacting index is affected, among other things, by

- the properties of the aggregate used,
- changes in the concrete mix,
- requirements owing to the casting machine and compaction method.

If it is known, for instance, that the casting machine works well when the compacting index IC80 = 2460 +- 20 (=2440 -2480 kg/m^3), it can be seen immediately from the result of the testing device, whether the concrete tested is acceptable for production. Here it is possible to take into account even small variations in the quality of the fresh concrete called for by the different casting machines.

Concretes with different mixtures can also be compared by means of this testing apparatus. Concrete admixtures sometimes greatly affect compactability, but it has been difficult to measure their effect by other methods.

4. TESTING ADMIXTURES USED TO IMPROVE COMPACTABILITY

In the production of hollow-core slabs, for instance, admixtures have been tested for improving concrete strength development and product quality. Substances tested have mainly included water reducing admixtures and air-entraining admixtures, which have proved to be good in plastic and super plasticised concretes. In general, tests have had to be performed in production plants in conjunction with full-scale production. This has resulted in time-consuming and expensive experiments, failures and production losses. Interpreting the results was also difficult, because the raw materials for concrete vary during a long series of tests.

The use of the new device for measuring compactability is a considerable aid in concrete research. The Development Centre of the Partek Corporation, located in Parainen, has performed expreriments on no-slump concrete containing admixtures for the Norwegian firm, Scancem Chemicals A/S.

Preliminary tests indicated that a surface-active agent is best for improving compactability. In the series of experiments performed the effect of the admixture dosage on concrete compactability and strength development were studied.

The concrete mix was made to correspond to fresh concrete used in the production of hollow-core slabs. Except for the admixture dosage, the mix was the same in all experiments.

The water-cement ratio was kept constant at 0.33. The fresh concrete was mixed in a 20 litre paddle mixer.

Table: Concrete compactability and strength with varying dosages of admixture

Scancompact Admixture Dosage %	Density, kg/m^3		Compressive strength MPa	
	40 cycles	80 cycles	24 hours	7x24 hours
0,00	2302	2372	35,8	40,2
0,05	2329	2422	41,9	47,4
0,1	2336	2415	40,5	46,7
0,175	2328	2433	40,8	46,8
0,35	2344	2411	37,3	46,0

The compressive strength after 24 hours and 7x 24 hours are both determined as the mean value of three cylinder samples. The test pieces were compacted during 80 cycles in the testing device and they were kept 24 hours in 90 % relative humidity and thereafter in water.

On the basis of the measured results one can conclude that even very small dosages (ca 0,05 %) of Scancompact admixture result in a considerable improvement in compactability and strength.

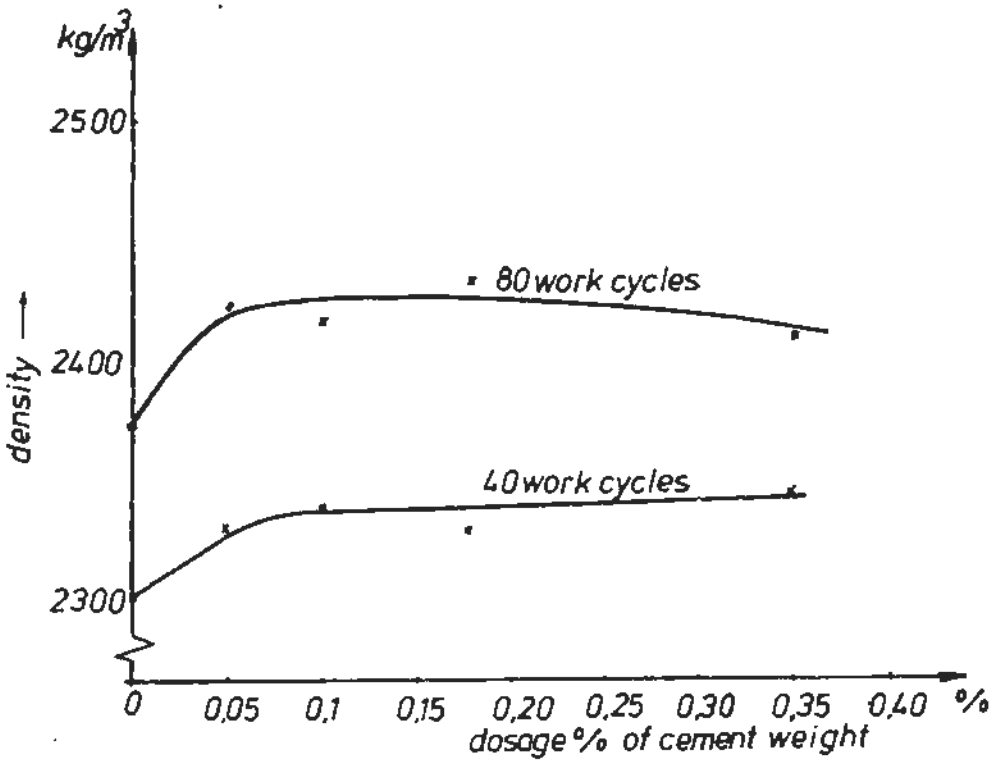

Fig. 3 Compactability depending on admixture dosage

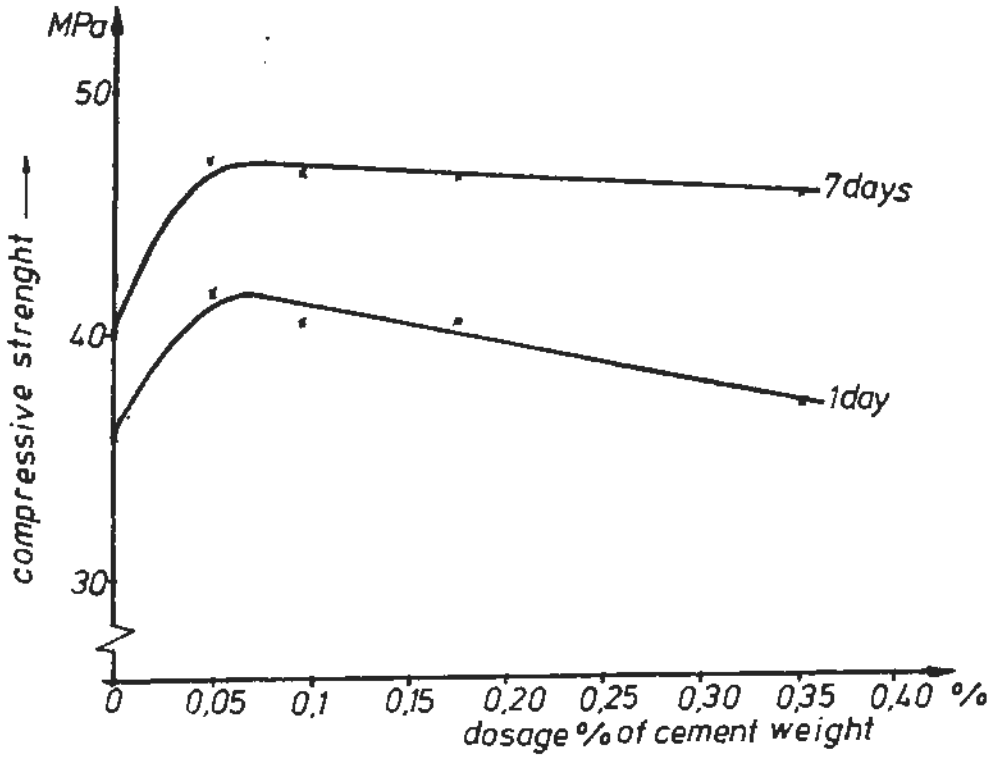

Fig. 4 Concrete strength depending on admixture dosage

5. ACCURACY OF THE APPARATUS

The device is able to identify any change in the compaction properties that is caused by an increase or decrease of 3 to 5 litres of water per cubic metre of concrete. Here it does not matter whether the water originates from the aggregate or whether it has been added to the concrete mixer.

The testing method is applicable to concrete with zero slump or with a consistency which gives Vebe times longer than 15 to 20 seconds.

6. APPLICATION OF THE TESTING METHOD

In addition to concrete quality control, the device can also be used in developing new concrete recipes and in admixture research. Green strengths can be measured on test specimens.

By manufacturing test specimens from different mixes, which the apparatus always compacts in the same way, and curing them, it is possible to compare many properties of the concrete quickly and reliably, especially factors having effect on the structure and quality. The compressive strength can also be measured directly from the cured specimens.

7. PICTURES

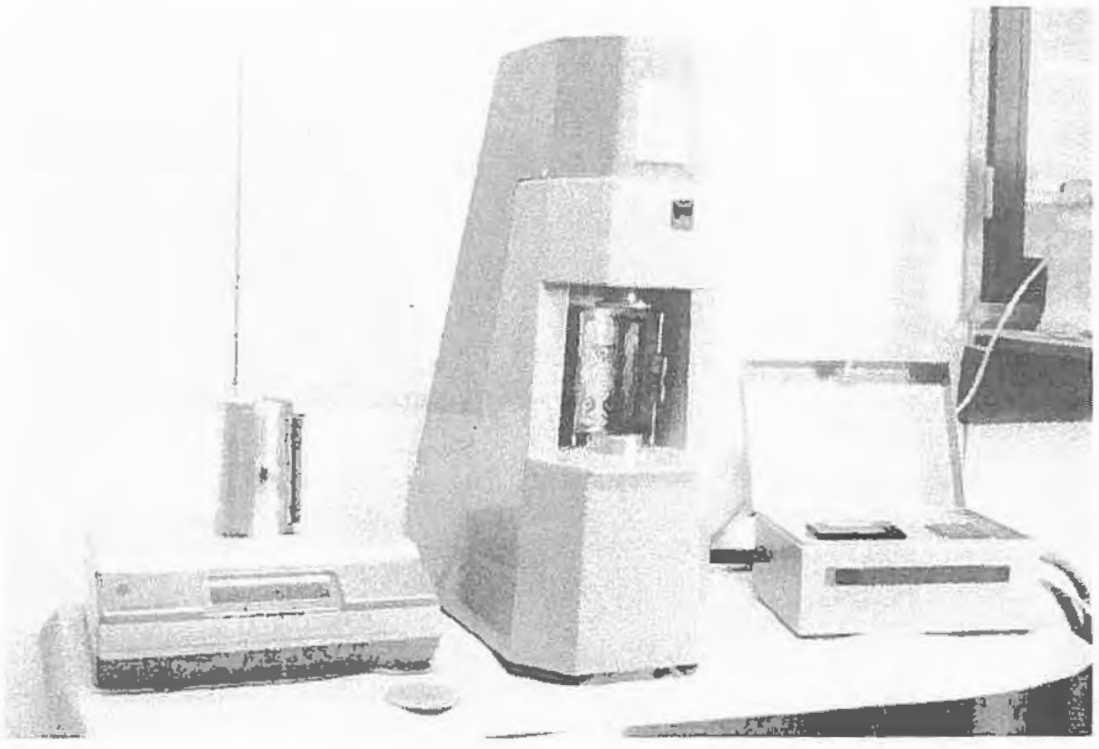

Photo 1 Testing device in centre, control and output unit on the right. The scale on the left can also be connected direct to the control unit. On top of the scale is the work cylinder in which the concrete sample is weighed.

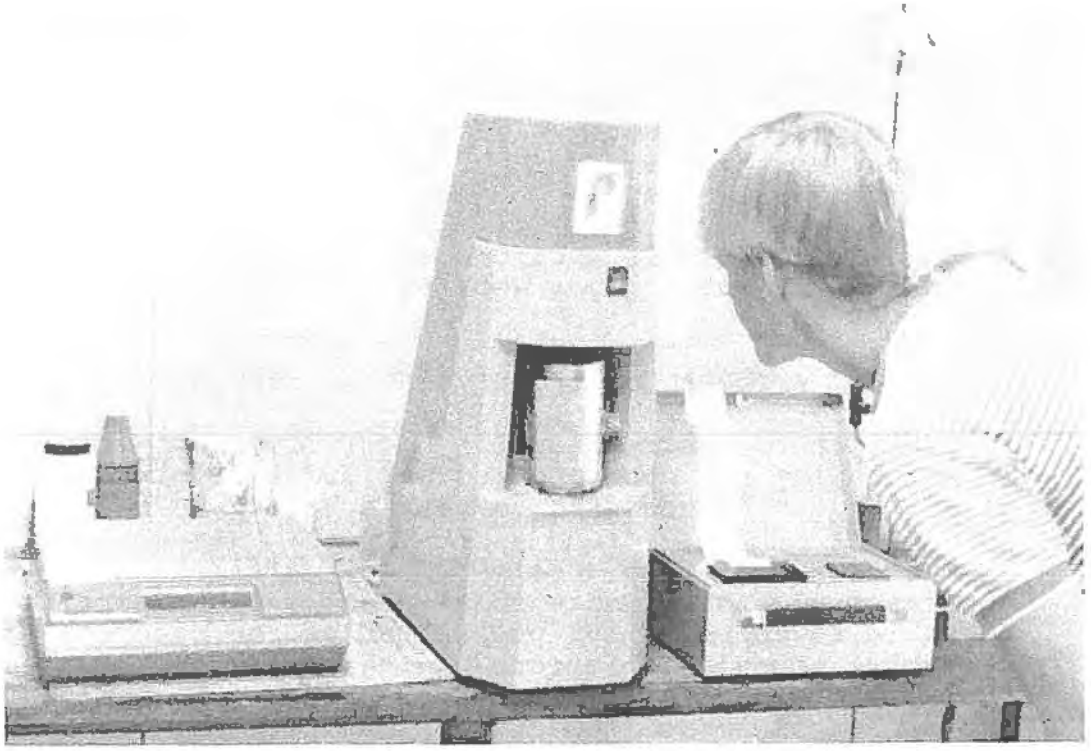

Photo 2 Device compacts concrete sample and simultaneously takes density readings. The control unit gives a print out of density readings.

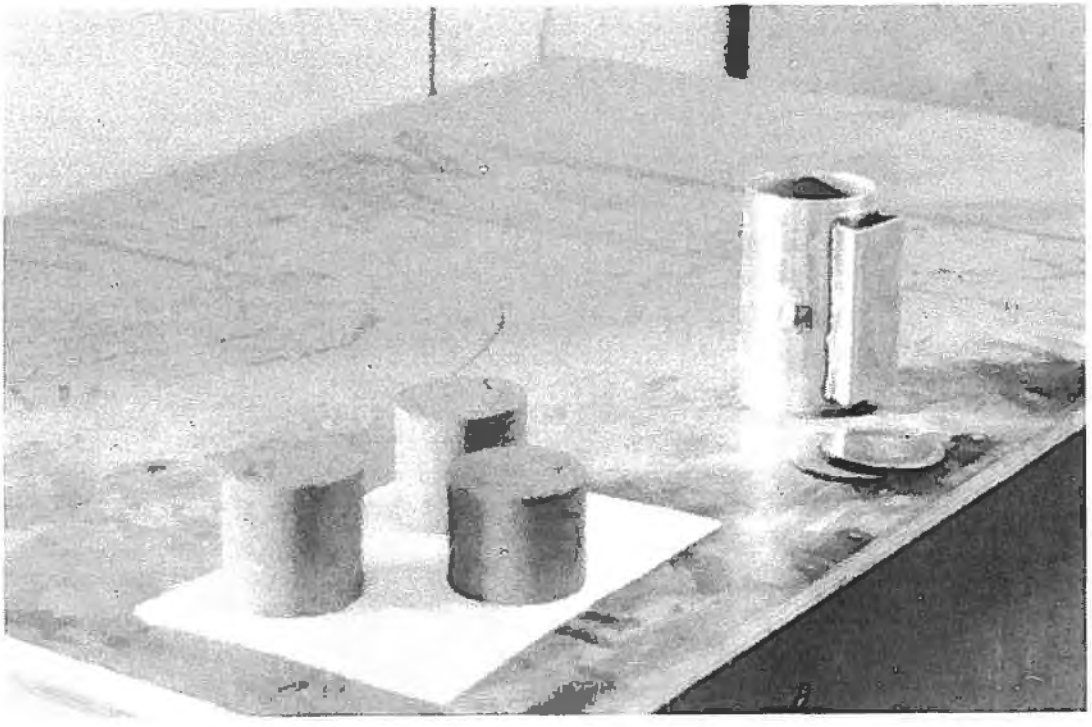

Photo 3 Compacted concrete samples and the work cylinder behind. If desired, the structure of test samples can be examined and they can be subjected to strength tests.