ACCELERATED WEAR TESTING OF HIGH STRENGTH ROAD CONCRETE IN NORWAY

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The Norwegian cement producer NORCEM has constructed, built and run a testing rig for testing different road pavings. The rig has mainly been used for testing high strength concrete.

High strength concrete has been found to give 2-3 times the wear resistance of asphalt. Wear resistance is here defined as wear resistance aganist studded tyres.

The influence of concrete mix design on wear resistance is outlined in the paper. The testing rig is still in operation and tests can be booked.

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Highways in Norway are almost hundred percent covered with asphalt. This is despite the fact that concrete paving has been proven to give far better wear resistance against studded tyres. Wear resistance against studded tyres is an interesting topic in our country, since Norway together with Sweden and Finland are about the only countries left who are using studs during winter season.

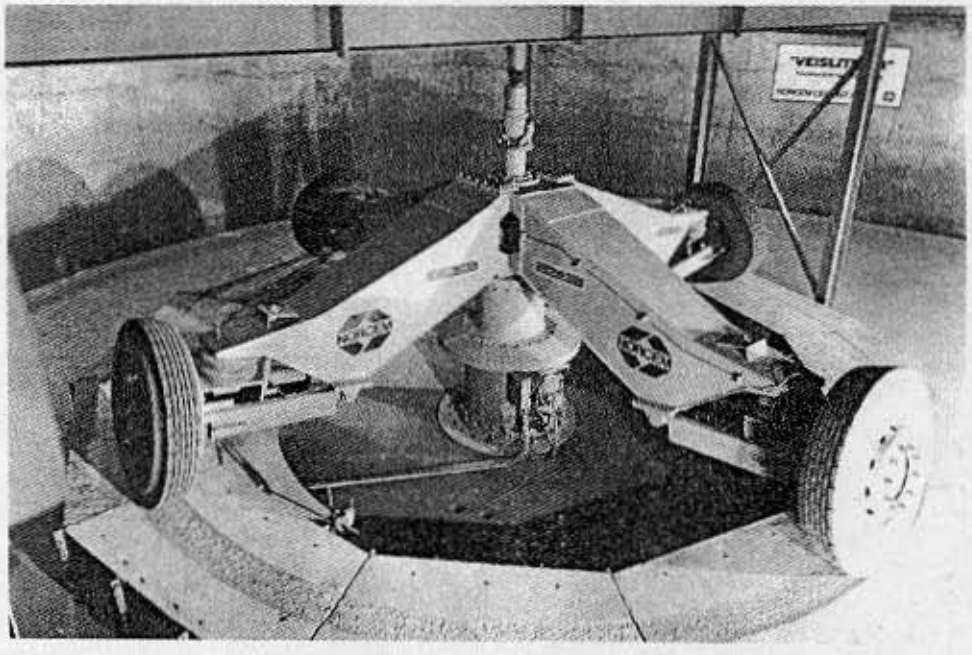
The last ten years from 1983, only about 100 kilometers have been paved with concrete. This figure also includes roller compacted concrete which is used to a certain extent especially in northern parts of Norway. When concrete is used as pavement it is mainly on bridges and in tunnels.

To improve this rather sad situation our Norwegian cement producer constructed, built and run a testing rig for testing wear resistance of road pavements against studded tyres. The aim of the project was to provide guidelines for mix design for road paving concrete to provide wear resistance and to investigate the wear properties of high strength or high performance concrete.

The testing rig consists of four truck wheels each of which is equipped with four hundred studs. The four wheels are run over a circular track. The track is built of twelve elements, pairs of elements are identical. This means that a comparison of six different mix designs can be done in one test. A picture of the testing rig is shown in fig. 1.

FIGURE 1

Testing rig



The speed, the axle load and the wheel pressure can be varied. The pavements under test are tested both under dry and wet conditions. Most tests have been carried out with speed 60 km/h, axle load 5 tons and wheel pressure 7kg/cm^2.

The wear is measured from the surface downwards and are given in millimeters. Calibration test runs have been carried out to establish relations between test results and real road wear. The testing rig accelerates real road wear up to ten years, one test runs for about one week. The rate of acceleration will depend upon the speed, the axleload and the traffic load that the real road is exposed to.

The variation coefficient of the testing rig was found to be 30%. Under the conditions tested the results show that the wear of a wet surface is more severe than the wear of a dry surface.

The main conclusion of the first 96 test runs are:

The most important parameter is compressive strength. The wear resistance increases with increasing strenth. This is the case both for dry and wet conditions.

This is shown for wear on dry surface in fig. 2 and for wear on wet surface in fig. 3. Both figures show spread in the results. The drawn lines are based on linear regression estimates. The correlation coeffisient r=0,48 (dry) and r=0,31 (wet)

FIGURE 2

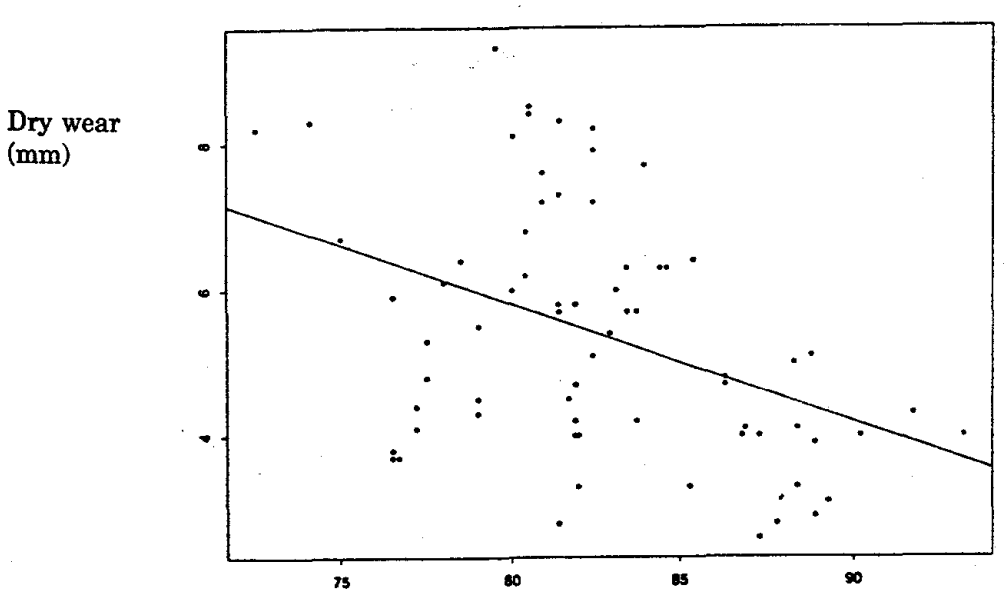


Fig. 2 Correlation between dry wear and compressive strength

FIGURE 3

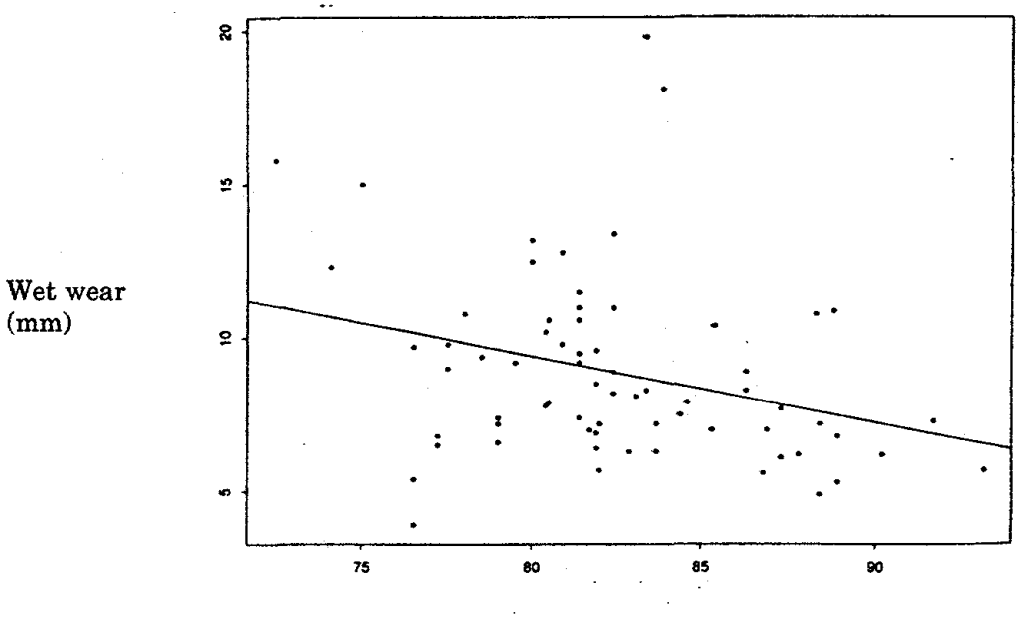


Fig. 3 Correlation between wet wear and compressive strength

A gapped grading has traditionally been recommended when designing concrete for road paving. There is no indication in the experiments carried out that a gapped grading improves wear resistance.

Addition of silica fume on level S/C+S = 0,10 (S=mix content of silica fume, C = cement) gives increase in wear resistance compared to concrete with the same level of compressive strength. This effect is more obvious on wet wear properties than on dry.

Paving blocks have also been tested in several test runs. the main parametre varied in these tests have been compressive strength, and rock type in coarse aggregate fractions The same correlation between wear and compressive strength have been found here.

The compressive strength are measured on 100 x 100 x 100 mm cubes, 28 days age. As mentioned earlier the variation coefficient of the test method is large. The results shown in figure 1 and 2 also show wide spread.

For this reason, the testing rig was dismantled and reexamined. In 1993 the testing machine was moved to Norcems production plant i Brevik, in the southern part of Norway.

It is now reestablished and it has been in operation since August 1993. Critical elements of the macine and the testing procedure have been improved. The improvement has led to significant reduction in the spread of results and hence in the standard deviation of wear values of identical elements. Block paving has not been tested after the reestablishment of the machine.

The rig is open for testing assignments, and has svereal orders from outside Norway. contact person is Director Birger Søpler, Norcem AS, 3950 Brevik Tlf.: +47-35572000 Fax: +47-35570400.