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THE STORAGE OF LIQUID ANIMAL WASTE IN CONTAINERS MADE OF CONCRETE AND ENVIRONMENTAL PROTECTION

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Abstract

Slurry storage is necessary for protecting the environment. Of the competitive construction materials, reinforced concrete is used the most. Farmers have been complaining for years that procedures for attaining building permits take too long, are difficult, involve too much red tape and constructional requirements. In a new experimental series, the penetration process within the concrete with slurry and water as a reference liquid was investigated.

Introduction

The methods of disposal and storage of liquid manure are very different world-wide. On one hand this is caused by very different types and sizes of farms; on the other hand it is also caused by various climatic conditions. On little farms in very small villages, as for example in southern Germany, litter has been in use during centuries. The animal waste was stored in small pits. The liquid parts generally were dripping from the ground plate of these pits, the small brown residues were leaking into the ground somewhere. This is no longer accepted.

The value of slurry as a fertiliser is well-known. As the plants consume by far most of the fertiliser in springtime, storage containers are needed. These containers must be large enough to contain the amount for six months. But there are tendencies to demand longer storage periods. In the Scandinavian countries they store slurry for up to one year. The Scandinavian authorities accept contracts between animal farmers and plant farmers concerning the size of the containers.

In Germany as well as in many other countries slurry containers are made of plastic coated steel as a wall, standing on a concrete platform, upright standing wooden poles on a platform, monolithic of concrete or as plastic lined "lagoons". Here, the concrete containers mainly are used.

Problem, Materials and Methods

There are lots of regulations dealing with the building of slurry, dung and silage juice, reservoirs world-wide. Purpose of these regulations is to avoid negative effects on the environment. More storage capacity is still needed.

Questions about the technical reliability of concrete slurry storage tanks arose in the late seventies, when some few, but big accidents by breaking tanks occured. This is why strict laws and regulations were made at the slightest suspicion of dangers.

Since many years there are complaints by farmers and engineers that the procedures to get a building permit are too long, they are difficult, and too many special authorities are involved. (In case of three demonstration slurry containers in the Eifel mountains, scientifically accompanied by

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the Institute of Production Engineering and Building Research of the FAL, 18 authorities were involved!)

By point of view of the authorities the problem focuses on the question, whether the containers are "tight" or not, as this is the main demand for example of the *German Water Household Law* (WHG).

First attempts with concrete core drill testing were abandoned due to the time lag between the effluent penetration and the visibility of the concrete bloc interior.

As a second attempt tests were carried out in a co-operation between the Institute of Production Engineering and Building Research of the FAL and the Technical University of Braunschweig. The tests were run in accordance with DIN 1048, which a.o. deals with the penetration of water into concrete under pressure. The testing was conducted on defined quality concrete samples, which for comparisons were made by two different manufacturers in the Braunschweig region. The recipies of the samples were 41430.F in the quality B 25 and 61433 in the quality B 35. Both recipies had the quality "water tight" (WU-Beton).

Because of the hardening process the tests started after 28 days at least, which is demanded by DIN 1048. During the tests a constant pressure of 0.5 N/mm^2 was held for a period of 72 hours. This equals 10 times the pressure, which may occur under natural circumstances in a container of 5 m of height. DIN 1048 Part 5 demands, that the average of maximum of three samples must be taken. The density of the slurry was measured as 1.012 [g/dm^3]. **Table 1** shows the list of the tests.

Table 1: List of tests

Transportable Concrete Manufacturers	Sample No.	Type of Cement/ Solidity class	Date of Manufacture	Age of Cement at Test Start	Penetration Depth	
					with water	with slurry
L	1 - 3	41430.F		15.04.00	3 x	-
	4 - 6	B25	16.03.00	30	-	3 x
	7 - 9	61433		18.04.00	3 x	-
	10 - 12	B35	16.03.00	33	-	3 x
W	13 - 15	41430.F		07.04.00	3 x	-
	16 - 18	B25	08.03.00	30	-	3 x
	19 - 21	61433.F		11.04.00	3 x	-
	22 - 24	B35	14.03.00	28	-	3 x
W	25 - 27	61433.F B35	17.04.00	15.05.00 28	3 x	-

Results

Figure 1 shows a typical example for a test with slurry, in a concrete of very good quality, it is a B 35. The maximum penetration is 10 mm, at a pressure of 0.5 N/mm^2. The penetration line does not go straight, which indicates that concrete is not a totally homogeneous material. The thickness of the concrete test bloc is 120 mm, that is much less than the concrete ground plate of a slurry container will have.

The same tests under the same conditions, i.e. concrete quality and pressure were carried out with water. Figure 2 shows the result: The maximum penetration depth is 18 [mm] now, which is more than the tests with water. The penetration line also does not got through straight. In the past many authors and agricultural engineers supposed that slurry is a material which can close tiny slits in concrete by its dry matter content. This could be proved now to be right for the first time.

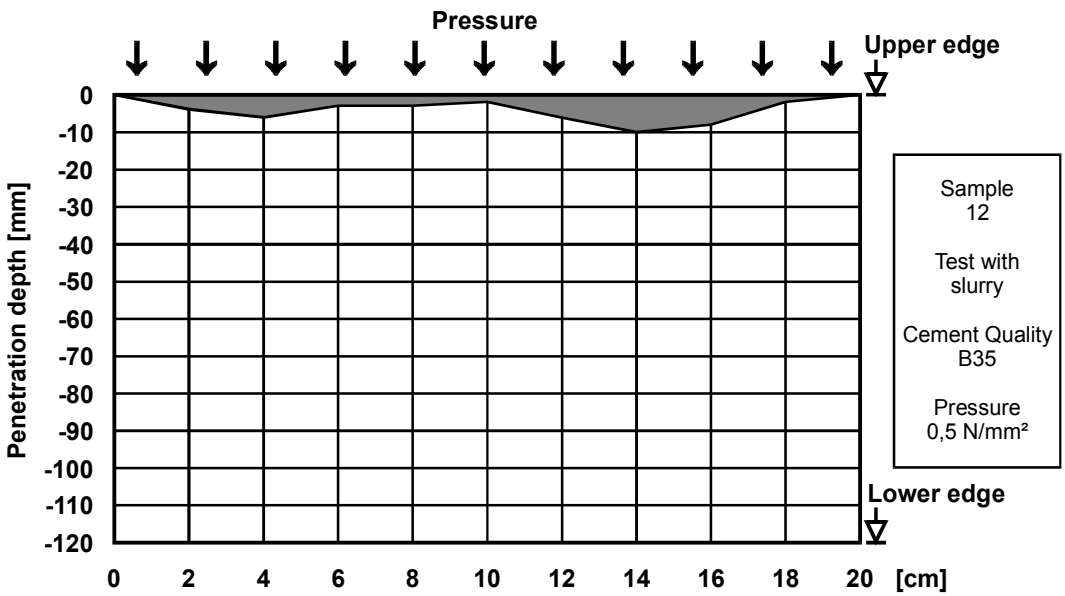

Figure 1: Penetration test with slurry

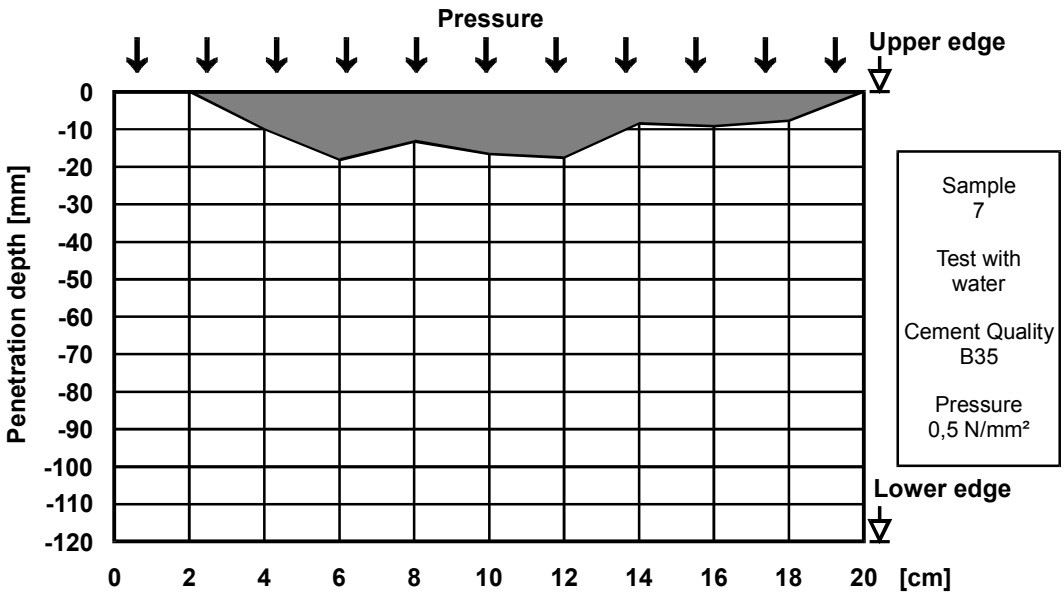

Figure 2: Penetration test with water

A complete list of the results and their averages (according to DIN 1048 Part 5) is shown as **Table 2**.

Discussion and conclusions

On the whole, the drillings measured with water were related to the values for slurry from 2 : 1 up to 3,4 : 1, with a mean of 2,4 : 1.

The concrete test containers did not allow passage of either water or slurry in any of the studies. Thus the requirements of Water Table Law as well as various state laws at slurry containers made of steel concrete be impermeable are met. The classification of slurry as a "dangerous substance" cannot be supported from the perspective of storage.

Table 2: List of Results in [mm]

Transportable Concrete Manufacturers	Sample No.	Type of Cement/ Solidity class	Penetration Depth			
			with water		with slurry	
			X	$\bar{x}$	X	$\bar{x}$
-	-	-	mm		mm	
L	1 - 3	41430.F	33; 19; 15	22	-	-
	4 - 6	B25	-	-	0; 18; 16	11
	7 - 9	61433	17; 20; 22	20	-	-
	10 - 12	B35	-	-	10; 5; 10	8
W	13 - 15	41430.F	17; 27; 16	20	-	-
	16 - 18	B25	-	-	11; 15; 7	11
	19 - 21	61433.F	44; 50; 47	47	-	-
	22 - 24	B35	-	-	12; 11; 20	14
	25 - 27	61433.F	15; 18; 13	15	-	-

The tests show that slurry penetrates less deeply into concrete than water under similar conditions. If water impermeable concrete (WU Concrete) is used for the manufacture of slurry containers, then from a concrete technology perspective, impenetrable slurry containers can be manufactured.

Furthermore, the constructive secondary conditions for the manufacture of water impermeable constructions according to DIN 1045 must be considered. Also the quality of the manufacture of slurry containers should be monitored and documented.

It would be desirable in the future that manufacturers guarantee the impermeability of the containers. This would certainly be a weighty argument which could speed up government approval processes.

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