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Environmentally Safe Slurry Storage

Situation in Germany and in Kenya

For no other construction project must as many different aspects be observed as for slurry store construction. They range from hygienic measures to prevent epizootic diseases, to selecting construction materials, up to regulating construction alterations. The two most important standards for constructing slurry stores, DIN 11622 "Silage silos and slurry containers" and the so-called concrete standard, which were revised recently, are elaborated on in this report. A new survey among rural construction societies revealed that a reduction in the number of regulations on slurry store construction, as promised by politicians, has not been achieved. Finally, a comparison of the situation in Kenya is presented.

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Keywords

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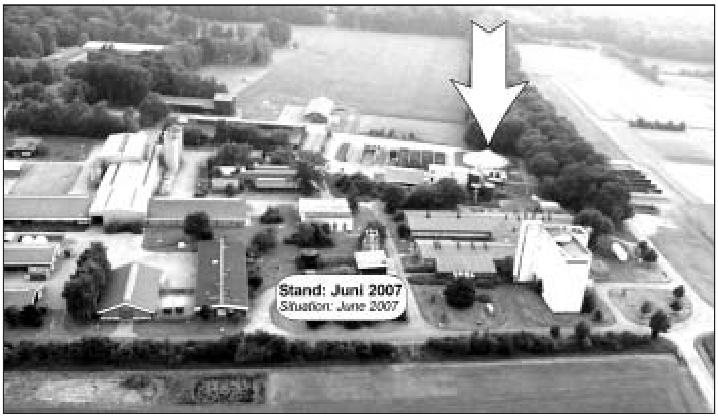

Fig. 1: Linking of a container to the composite slurry system

For the reduction and acceleration of permit procedures under the immission protection law, a bill has been submitted to the Federal Council, which is very likely to be adopted. The environmental committee has already adopted the draft including the reduction of the permission requirements for animal housing facilities, which had been agreed on by the parliamentary groups of the coalition. This bill provides that permission under the immission-protection law for farms housing more than 50 livestock units (LU) and more than 2 LU per ha will be abolished entirely. In addition, permission under the immission law is only required from 600 places upwards for cattle stalls and from 500 places upwards for calf stalls. The decision of the Federal Council is expected at the end of September 2007.

New Standardization

With the revision of DIN 1045, not only new terms were introduced, but also new concrete classes were standardized in a narrower grid than before. This allows the planner and the user to consider the individual elements of the concrete more precisely so that calculations can be optimized even more. Parallel to the "new" DIN 1045, the European standard DIN EN 206-1 was introduced. For better understanding, the different types of concrete relevant for slurry container construction are listed with their new and old classification:

B15 approximately corresponds to C12/15
B25 approximately corresponds to C20/30
B35 approximately corresponds to C30/37

The old type B5, which was often used as a subbase instead of a compacted gravel hardcore, is no longer included in this classification. Concrete types with greater pressure resistance (C40/50 and higher) are not required for the construction of slurry containers.

The most important standard for the construction of silage silos and slurry containers is DIN 11622, which was published for the first time as early as 1949 and has been updated several times. This standard has now been revised completely and adapted to the new regulations. It applies to silage silos, slurry stores, and horizontal silos which can be driven over [1, 2]. In principle, the bottoms of these containers are made of steel concrete. The walls can consist of different materials. This standard contains special regulations for different kinds of concrete construction with prefabricated parts, moulded and formwork stones. Due to the high requirements for concrete, the use of ready-mixed concrete is explicitly recommended for all concrete parts out of site concrete.

The most important requirement is that all containers must be built such that they remain permanently functional. For this purpose, first static calculations according to DIN 1055 "Design load for buildings" (here: "Storage materials, construction materials, and construction parts") must be carried out.

In these calculations, DIN 1045 "Concrete and steel concrete" must be observed. In addition, water management requirements apply, according to which "containers must be constructed, put up, maintained, and operated such that the best possible protection of water against pollution is achieved" [3]. In the past years, this principle has been strengthened by numerous individual regulations, which have often been enacted at the regional level.

Problems Caused by the Connection of the Experimental Container to the Compound Slurry System

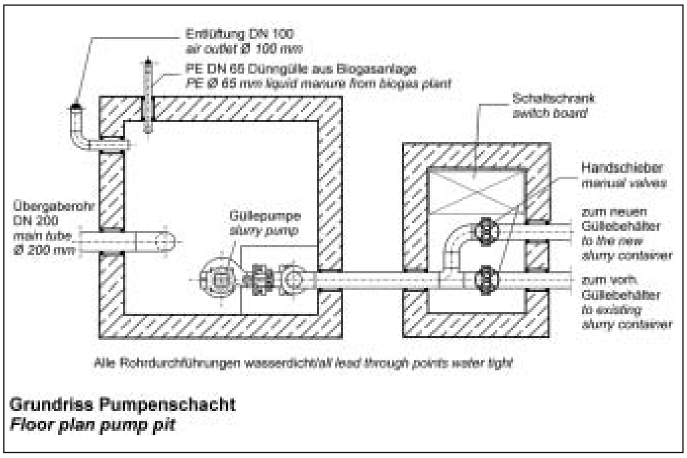

Fig. 3: Floor plan of the pump pit

The origin of the Research Station in Brunswick dates back to the early 50s. Under Professor A. Köstlin, the former director of the Institute for Farm Building Research founded in 1953, the construction of experimental buildings was begun, for which the few construction materials available after the war were used. Reinforcement iron for construction parts out of compressed concrete, for example, was gained through hard manual labour from blown-up war concrete. The construction of slurry stores was already necessary at that time. Since then, the Research Station has grown slowly, but steadily (*Fig. 1*). The aerial photograph shows the current state. The arrow marks the new experimental container (V = 1,500 m^3).

The size of the facilities shows that the pipes are very long and extend over several hundred meters. Since slurry de-mixes into the three phases solid settling matter, effluent, and floating matter, the fear was that some branches of the pipes may clog up. Such obstructions would have been very difficult to remove. Experience showed, however, that the system of pump pits and pumps constantly homogenizes the slurry. For the above-mentioned reasons, however, this does not allow any recommendations for practice to be derived. On the contrary: the connections between the stall building, the slurry pit, and the storage container should be kept as short as possible. Recommendations provide, however, that storage containers should not be placed on the outward extension of the longitudinal axis of the building so that they are not in the way for future extensions.

It is often difficult to integrate a very large slurry container into the entire group of facilities, because these are often very voluminous buildings, which are up to 6 m high. Farm building experts are not the only ones who agree that for reasons of practiced environmental compatibility unsightly large blocks in the landscape should be avoided. The division of the store into several small ones is excluded because this would lead to a significant increase in the relative building expenses in € per m^3. As a solution, the sinking of large containers into the ground suggests itself. As shown by the horizontal dotted line in the cross section of the experimental slurry container (*Fig. 2*), this container was sunk by more than 2/3 of its construction height. The trees around it were then sufficient in order to almost reveal even the PE membrane (manufacturer: company Ceno), which was put on top of the container as a cover.

The question of whether the points where the pipes cut through containers and slurry pits are "tight" as defined by the Water Management Act has hardly been discussed in the literature so far. Doubts about the tightness of these points may be raised by the hypothesis that the different thermal expansion coefficients of the materials steel concrete, plastic, and galvanized pipe steel lead to a loss of contact adhesion during temperature changes. As a result of this argumentation in a large number of construction permit procedures in the past, the filling and draining pipes of slurry stores really had to be installed above the edge of the container. One must say, however, that these cut-through points lie under ground and that therefore no noticeable temperature fluctuations may occur. In addition, no such defect has ever become known to the author of this contribution. Nevertheless, all cut-through points in the experimental container were equipped with prefabricated pipe ducts (*Fig. 3*), which have been used for drinking water for a long time. The layout of the pump pit shows that two separate pits were dug for safety reasons because of the numerous pipes. The entire facility is under long-term observation. So far, no problems have occurred.

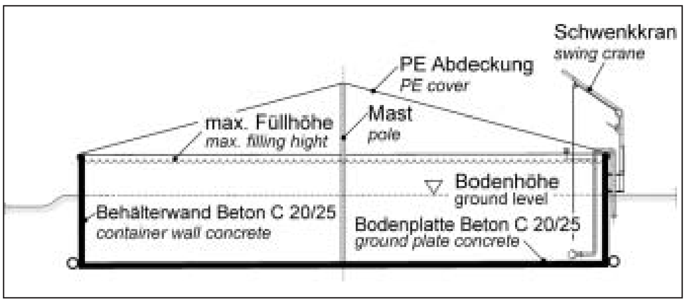

Fig. 2: Section through slurry container with caving in

Application of the Law in Construction Requirements

A new survey among rural construction societies was intended to answer the question of whether construction requirements have been noticeably reduced in current construction projects. One rural construction society each from the federal states of Lower Saxony, Hesse, and Bavaria participated in this survey, which provided the following overview of the relevant requirements which apply today:

• For slurry storage, the Fertilizer Decree from 26th January 1996 (Federal Statute Book, I, page 118) must be observed. The volume of the demanuring channels in the satble may not be considered in the calculation of the required storage capacity. The capacity of the slurry facilities must be larger than the necessary capacity for the storage of slurry during the longest period in which the spreading on agricultural areas is not permitted.

• For the slurry channels and the slurry pit, grade B 25 WU concrete must be used. The liquid level in the channels may rise to no more than 20 cm below the slatted floors.

• The operator must regularly check the facility and in particular carry out visual tightness checks. The slurry gate valve must be maintained annually.

• Leak detection measures can be dispensed with if the liquid-filled cross section of the slurry channels does not exceed 6 m^2 and the construction height of the channels is lower than 1.50 m. This regulation exclusively applies to demanuring channels and not to channels built for slurry storage.

• The tightness of permanent pressure pipes

must be checked in a pressure test according to DIN 4279 at the 1.3 fold operating pressure by the construction company in the presence of the owner. A pressure test is not necessary for pipes used for demanuring.
• The filling and draining pipe of the container must be slurry-resistant, liquid-tight, and stable. The draining pipe must be secured against unauthorized opening with the aid of two separate automatic shut-off systems.
• The slurry container may only be commissioned after inspection by the Lower Water Authority. The owner must make an appointment for inspection without prior notification by the authority.
• Before final inspection, the responsible entrepreneur must examine the tightness of the container and the pressure pipes in the presence of the owner. This examination includes a tightness check of the free-standing and not back-filled container, which must be filled with water up to a height of at least 50 cm over a period of 48 hours. During this period of observation, no visible water leaks and no penetration of moisture may occur. Filling quantity, time and date, as well as the result of the tightness check are recorded. A copy of this record must immediately be sent to the Lower Water Authority. After the maximum slurry filling height has been reached, representatives of the Water Authority carry out another visual check after notification by the owner.
• The operator must regularly check the tightness of the slurry container including the facilities which belong to it.
• A freeboard of 20 cm must be kept anywhere around the slurry container.
• A minimum distance of 50 m from stretches of surface water must be kept.
• The construction of a liquid-tight filling place with a sufficiently dimensioned catch pit in front of the slurry storage container can be dispensed with if the overhead container is not filled beyond the edge of the slurry transport container.

All in all, one must say that the number of regulations in this area has not decreased. It remains the urgent obligation of politics to avoid disadvantages for German agriculture within international competition.

The faultlessness, which is now guaranteed by some companies can be considered a contribution of the construction industry to the acceleration of construction permit procedures. The company Suding, which offers a 5-year warranty, can be mentioned as an example.

The Situation in Kenya

Kenya is a country situated in Eastern Africa at a latitude between 4° N and 4° S and a longitude between 34° E and 42° E. It has a size of 584,000 km? and a population of approximately 34 million. Agriculture plays a very important role there. Approximately 75% of the Kenyans are dependent on it, and it accounts for about 26% of the gross national product. Due to the climatic conditions, however, only one third of the area can be used for agriculture, namely regions in the highlands, the coastal plains, and the lake region. The other areas are semi-arid to arid and are used by shepherds for pasture. Despite the strong climatic differences, dairy farming plays a very significant role in Kenyan agriculture. Table 1 shows the statistical data of livestock in Kenya [4].

Agriculture in Kenya is characterized by a large number of small farmers on small plots. As a result, animal excrement is not produced in large quantities. Channels and dung heaps are covered in order to avoid evaporation and to conserve nutrients.

Of course, this kind of storage poses a threat to surface and ground water. In order to avoid contamination of soil and water, proven methods for the reduction of the sources, the storage, as well as the distribution and use of animal excrement as fertilizer are necessary. This also applies to composite material for cofermentation during the composting process [5].

Of course, the nitrification problem is known in Kenya as well. However, it is not considered as important as in Europe. Nevertheless, slurry is estimated extraordinarily as an alternative fuel source for cooking and illumination. Based on several studies on climatic change, the conclusion was drawn that animal dung was the best source for the production of methane gas. Therefore, the Kenyan government supports the construction of small biogas facilities with standardized reactor sizes of 16 m^3, 30 m^3, and 50 m^3 throughout the country. These reactors are not welded or concrete-built, but constructed using bricks. Construction is supervised by a civil servant, while the realization of the construction project is taken over by the owner or the cooperative. Slurry containers out of concrete, which are exclusively used for fertilizer storage, are not built, even though this would be appropriate under environmental aspects.

Jahr / year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Rinder / cattle	11,50	11,40	11,70	12,80	11,70	22,80	11,50	12,50	12,00	12,00
Schafe / sheep	7,70	7,60	7,00	8,50	7,90	7,60	7,40	9,90	10,00	10,00
Ziegen / goats	10,30	10,90	9,70	11,00	10,00	11,00	11,00	11,00	12,00	12,00
Kamele / camel	0,96	0,79	0,80	0,81	0,82	0,83	0,83	0,83	0,83	0,83

Table 1: Kenya statistics for Livestock numbers for the period 1996-2005 (M.) [4]

Conclusions

At different levels, politicians had announced a reduction of regulation density (bureaucracy). The Federal Council is now deliberating a bill which provides an acceleration of the permit procedures. A decision is expected in September 2007. A proposal of the Institute for Production Engineering and Building Research of the Federal Agricultural Research Centre, which provided that the construction industry should give a manufacturer warranty for the faultlessness of slurry containers in order to accelerate construction permit procedures, has been realized in practice.

A comparison with Kenya as a typical African country in the course of development shows that nitrification problems do not cause much concern there. However, solid and liquid animal excrement is a welcome raw material for fuel production and illumination in this country. In order to avoid unwanted immissions into soil, water, and air, technically better slurry stores are urgently required there.

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