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New Developments in Horizontal Silo Construction

Horizontal silos are the constructions with the highest damage rate in agriculture. For this reason their durability has been under discussion for years. Damages noted result mostly from construction mistakes. The main causes are improper concrete composition, careless construction or reinforcement cover flaking. In many cases the concrete is only the load bearing foundation; the surface is then improved with a covering or paint. Construction mistakes can also occur here. At the FAL experimental station in Brunswick a new facility was erected, which combines a manure plate, horizontal silo units, effluent receptacle and a collector basin.

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At this point in time, forage storage is still possible in unsealed field areas if the location is changed annually. For permanent storage at one location, a solid ground plate is required. Here the requirements for ground water protection according to DIN 11622 apply.

Permanent facilities with paved soil plates also exist, which do not meet the requirements of DIN 11622. These are used to store silage with a high dry matter content, since here no silage effluents originate. A particular advantage of these facilities is that both the paved access roads and cutting area can be kept cleaner.

In any case, a tight covering against precipitation should be available in order to prevent possible leaching. But due to the desired silage quality, this is probably available in most cases. Essentially a number of laws and regulations apply for the storage of slurry, liquid manure and solid manure and especially for silage in order to prevent disadvantageous effects on the environment (soil, water and atmosphere). In terms of authority, the following hierarchy exists: EU, national, state and communal law.

Horizontal Silo Construction in General

As a rule, horizontal silos are comprised of a 7.00 m to 8.00 m long strip with 1.50 m to 2.50 m walls. The stacking level in horizontal silos is much lower due to the danger of collapse through compaction.

The construction of the base of a fermented feed horizontal silo consists of the soil plate, an anti-slip layer and the carrying layer on the bottom. The permanence of horizontal silos is to a large extent dependent on the adequate carrying capability of the subsurface. If the subsurface has unequal carrying capacities, then either the bottom must be replaced or a different location be chosen.

The slope of the soil plate is established in the soil excavation of the subsurface. Thus all layers can be created in the same thickness. Today a slope of 1.5% is generally accepted, in earlier years regularly higher values were also attributed to a possible in-

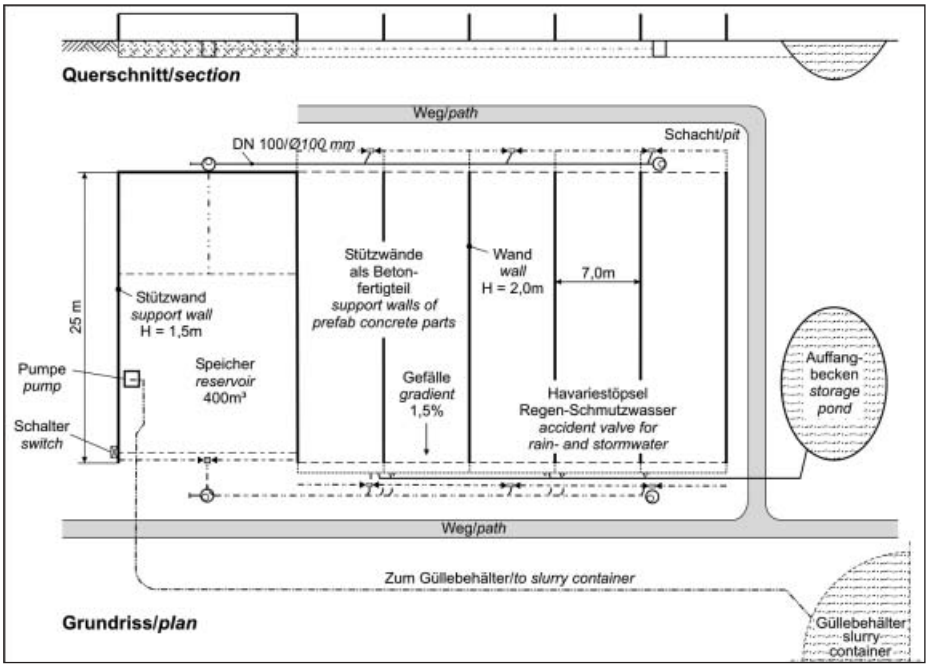

Fig. 1: The new horizontal silo in the research station Brunswick of the FAL (Federal Agricultural Research Centre)

exactness in the creation of the upper layer by error or gauge. The large area silage surfaces are manufactured with machines and are absolutely even. The thickness of the carrying layer should not be less than 15 cm. The surface of the carrying layer should be as even as possible in order to get below the minimal thickness of the soil plate. Sand and gravel are appropriate materials for the carrying layers since they can be well compacted. Damp soil material can be better compacted than dry material.

To minimize the danger of cracks in the soil plate, an anti-slip layer is placed between the carrying layer and the soil plate. Suitable here is a two-layer plastic foil, with each layer 0.3 mm thick, laid down with about 25 cm overhang. The strips should overlap by at least 50 cm.

Silage plates and horizontal silos must be impermeable. This is established by the Federal Water Act (WHG 319g). According to DIN 11622, the thickness of the base plate should be at least 18 cm.

New Horizontal Silos

At this time, increased construction of horizontal silos is being reported in Southern Germany. Here, not only the previously mentioned basic forms are used, but also new construction forms with further developments can be seen. As in all of agricultural construction, the developments here stem mostly from increased amounts and the subsequent construction enlargements.

One novelty are large format pre-fabricated wall elements of concrete steel which can be made up to 15.00 m long and 3.50 m high. In this manner, the seams between the elements are largely eliminated. As a standard, 10.00 m pre-fabricated lengths are recommended.

A further development is the so-called Jumbo A Parts of Concrete steel, in which two relatively thin plates are placed against each other in an A-form. This ordering makes very good compression possible.

The Traunsteiner Silo, known for years, has also been further developed and now consists only of concrete pre-fabricated elements on earth walls.

Unfortunately, further details cannot be provided at this point due to space limitations. Details can be obtained from the author of this article.

The "New Horizontal Silo Combination" in the German Federal Agricultural Research Centre (FAL)

In the FAL Experimental Station in Brunswick, a new facility was built in which all possible traps were considered. This is presented in the ground plan and view in *Figure 1*. The facility is comprised at the left from a bunker accessible from the top through two manholes, a solid manure storage area above this, which is surrounded on three sides with concrete walls (h = 1.50 m). The soil plate has an upper layer of bitumen-flux mixture. At the right there are five strips for feed silage, each 7.0 m wide, with 2.5 m high walls, which widen towards the bottom in a cone form. The soil area is coated as required; the walls are coated with bitumen.

To fully prevent the escape of silage effluent into the soil, a discharge system was included for the various possible cases. The normal situation is the slow seeping of leaching fluids according to the constructed tilt in the direction of a gutter. Since the covering is electro galvanized in gray, it is difficult to see against the background (*Fig. 2*). The lines running from the top to the right bottom mark the blind joints which are milled straight. They are subsequently filled with liquid bitumen in order to prevent the permeation of rain water. They serve as a predetermined breaking point, should the forced tension due to strong temperature swings of the crawling or loss of concrete occur, which could otherwise lead to uncontrolled cracking.

On the left edge of the illustration a discharge gutter is shown, running from the top to the bottom should strong rains leach and wash away silage effluent. At regular intervals, small covered sections are located as the transfer point for the discharge system which leads to the accumulating container at the far right of *Figure 1*. In addition, the possibility of transferring the waste water mixture from the deep container to the large slurry container with the help of a pump is at the far right of Figure 1.

It is possible to drive around the entire facility. This should contribute to cleanliness in the direct vicinity of the facility.

Overall this facility should help to avoid all possible cases of environmental pollution. Whether this high level of security is necessary in practice must first be considered on the basis of long term observations including under extreme weather conditions.

Summary

As already reported for the construction of slurry and liquid manure storage, in the construction of forage storage the perspective of environmental pollution is moving to the forefront. The solutions implemented today are completely acceptable.

Here, though, it is essential, that the valid and continually improved "Construction rules" be observed and implemented. Self-made "chicken manure concrete" cannot fulfill these requirements, not even if an additional sack of cement is added to the finished mixture. The pre-mixed concrete offered by the cement industry today meets the requirements to the fullest extent. Thus the use of this concrete is expressly advised.

The mixtures offered by the asphalt industry to coat the carrying layers against strong acidity have also been developed further. Past problems when using evaporating solvents have been solved.

Fig. 2: Arrangement of concrete slit and drain trench

Literature

[1] *Brand, J., und H. Klose* : Planung und Bau von Gärfutter-Flachsilos. Bauberatung Zement, Zement Merkblatt Landwirtschaft, Beton-Verlag, Düsseldorf, 2003

[2] *Goldenstern, H.* : Erfahrungen beim Bau von Güllebehältern, Gärfuttersilos und Festmistanlagen. Bauen für die Landwirtschaft 1.99, (1999), S. 14-16

[3] *Talabani, S., G. Hareland und M. R. Islam*: New additives for minimizing cement body permeability. Energy Sources, (1999), no. 21, pp. 163-176