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Environmentally Friendly Storage of Solid Manure and Silage

The construction and operation of solid manure and silage plates as well as horizontal silos requires permission, if they […] are operated at the same location for more than 12 months (from section 1 of the 4th Federal Immission and Ambient Pollution Control Ordinance). The relevant regulations are governed by the Federal Immission and Ambient Pollution Control Act, which serves as a basis for the decision about a permit for the entire animal housing facility. This law, which significantly restricts structural change in agriculture, has now been simplified. At the Johann Heinrich von Thünen Institute in Brunswick, a large plant for the environmentally friendly storage of solid manure and silage, which is intended to meet all criteria of environmental compatibility, even under extreme weather conditions, was completed after the end of the second construction phase.

On large and medium-sized livestock farms, a solid concrete or base plate surrounded by walls on 3 sides, which is "tight" as defined by the Water Management Act, is required for the stationary storage of dung and silage [1]. According to DIN 11622-1, definitions are used which were introduced after numerous compositions of substances and building designs caused insecurities as to whether or not the mentioned standard must be applied.

New immission protection law

For quite some time, practitioners and in particular farm construction counsellors demanded a simplification of the immission protection law [2]. After a long way through the political institutions starting with the Environmental Committee, the Lower House of German Parliament adopted the Law Regarding the Reduction and Acceleration of Permit Procedures Governed by Immission Protection Law slightly later than planned in its session on 23rd October 2007. After approval by the Federal Council, this law was published in the Federal Law Gazette (volume 2007, part 1, number 53, pp. 2470 - 2475) on 29th October 2007.

The currently applicable regulation provides that permission under the Immission Protection Act is completely abolished for farms having more than 50 livestock units (LU) and more than 2 LU / ha. Permission is only required for cattle houses which offer 600 places or more or for calf houses having 500 animal places or more.

The relevant numbers for farms where other animals are kept (hens, pullets, fattening poultry, turkeys, fattening pigs, sows, piglets, fur animals, and mixed livestock) are listed in a table (loc. cit., p. 2470 – 2472 [3]).

Construction of a large storage facility for dung and silage

In 2007, the Federal Statistical Office in Wiesbaden carried out a survey of agricultural structures which showed that the number of farms in Germany had fallen by ~ 5% since 2005. In the same period, however, the cultivated area remained virtually unchanged. This proves that structural change in agriculture towards ever larger farms is continuing [4].

For livestock farms, this means that the disposal of animal faeces in any form and the storage of silage require larger facilities. Naturally, this arouses increased attention from the authorities responsible for environmental protection.

Given these conditions, the construction of a facility for the storage of dung and silage was begun at the Johann Heinrich von Thünen Institute (the former Federal Agricultural Research Centre FAL) in Brunswick/Germany last year. In this facility, both silage effluents from the tracks of horizontal silos and slurry seeping out of dung are collected and stored in one common system. After the end of the second phase of construction, the facility has now been completed.

Design description of the facility

The facility consists of a central dung plate 15 m • 25 m in size, which is surrounded by

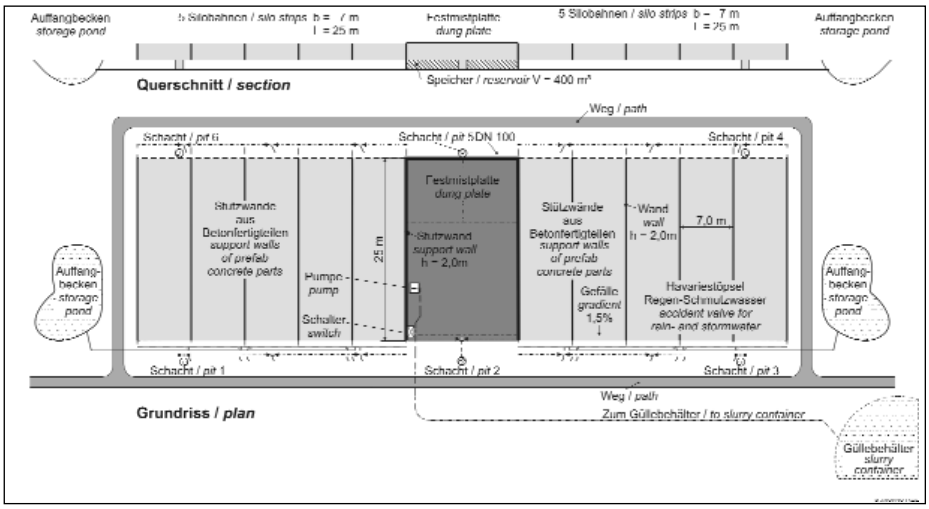

Fig. 1: Combined storage for dung and silage

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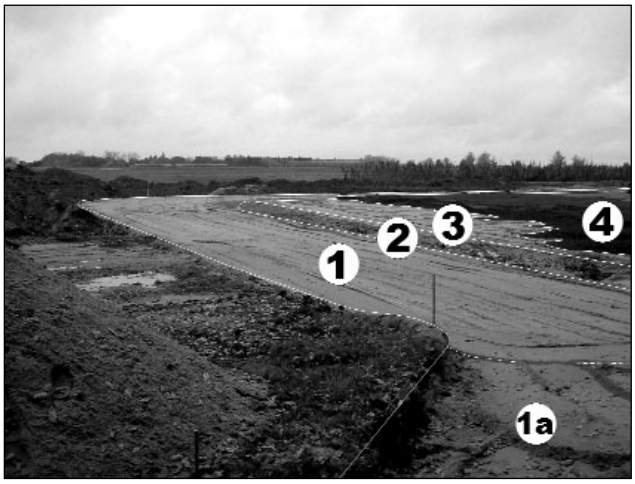

Fig.: 2: Underground structure of a horizontal silo

walls (h = 2.00 m) out of prefabricated steel concrete parts in the back and on the sides. The plate has an inclination of 1.5% towards the front and is connected to the disposal channels. The concrete plate consists of cast-in-place concrete and features a covering layer out of asphalt. For the side walls, smoothed exposed concrete is used.

For the collection of rainwater contaminated with dung and silage, a reinforced concrete container underneath the dung plate was planned. The cover can be driven over by vehicles. Both the cover and the driving area consist of one piece. The clear height of the container is 3.00 m, and the complete cover including the wearing course is 35 cm thick. The container was adapted to the dung plate, and its clear height was limited to 3.00 m. This provides a volume of 1,125 m^3, which is sufficient for approximately one year even after the completion of the second phase of construction. On 14th July 2008, filling height was 1.50 m (after 2 summer periods and one winter period). So far, the pump has not yet started to operate. On the right and the left side of the central dung plate, 5 horizontal silo tracks (width: 7.00 m. length: 25.00 m) were arranged, whose 2.00 m tall partition walls consist of prefabricated concrete parts. The walls were coated with paint resistant to effluent (black). As a bond between the walls, a base course out of reinforced concrete with a wearing course out of asphalt was installed. In order to guarantee a frictional connection, a company from Hanover which specializes in iron braiding inserted 750 angled iron parts on each side. Afterwards, the concrete was cast using a concrete pump with a 36 m extension arm. In order not to interrupt the material flow, five 4-axle concrete transporters were at the construction site. Since the reinforcement mats were rather close to each other, a thin vibrating cylinder had to be used for vibration. *Figure 1* shows the complete facility.

For fall protection, galvanized rectangular tubes with taut ropes were installed on the silo walls. The base points of these posts consist of strong sheet metal claws which are attached to the walls using S8 pins. The bolt heads consist of 13 mm hexagon nuts so that the railing or parts of it can be taken down quickly with the aid of normal tools.

The entrance and exit sides of the horizontal silos are bordered by wide manoeuvring strips consisting of a stable foundation with an asphalt cover [5].

Foundation

Before the beginning of construction, a soil engineering laboratory had examined the foundation soil for its stability. The results showed that the soil could not be sufficiently compacted up to a depth of ~ – 1.00 m. *Figure 2* shows the different zones of the foundation required for this reason on the left side of the horizontal silo facility (right side mirror-inverted).

- Area 1a: Access to the facility, connection between the asphalt road and the facility. Removal of a 30 cm topsoil layer, soil excavation, filling with soil, compaction with a vibrator Afterwards application of a 30 cm layer of frost-protection gravel The 30 cm mineral bearing layer has not yet been applied in the figure.

- Area 1: Bypass of the entire facility Soil structure like in 1a.
- Area 2: Strips for shafts and pipes. Frost-free excavation, lateral storage of material for recycling, filling of the strip with soil and installation of shafts and pipes. Vibration of the area.
- Area 3: Foundation of the horizontal silo facility like in area 1, though vibration in thinner layers.
- Area 4: In addition to the structure of area 3, the bearing mineral layer is applied and compacted by rolling.

The set-up of the prefabricated wall elements could only begin after these steps had been completed. Afterwards, the reinforcement iron was installed, and the concrete was cast.

Fig. 3: View of dung plate

Description of the drainage systems

The silos are inclined in the direction of area 2 in *Figure 2*. Here, a continuous drainage channel with a grid cover is installed in front of the silos. This channel is connected to two pipe systems for unpolluted surface water and water contaminated with effluents. The latter is drained into the storage container. If necessary, a pump starts to run which conveys the mixture into a nearby high-level slurry tank.

The dung plate is connected to the system by an inclined area which is identical with area 4 described above (*Fig. 3*).

Conclusions

Due to "growing mobile point loads" (e.g. large wheeled loaders), the construction of an environmentally sound plate or a horizontal silo for dung and / or silage requires a carefully planned and realized foundation. This also explains the strong reinforcement of concrete.

In the facility built in Brunswick, several drainage systems for slurry, effluents, and rain water were combined. Observations after the first construction phase were positive. In no case was effluent drainage different than planned.

In the future, a simplification of drainage system construction is expected. This not only reduces building expenses, but also improves functional reliability.

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