Simon, Jochen and Stötzel, Peter

Development of a milking robot compartment made of prefabricated concrete parts

Automatic milking systems are characterized by a compact design and low assembly requirements. The goal of this project was the development of a modular milking robot housing system, whose construction is simple, flexible, and inexpensive. Prefabricated compartments made of reinforced concrete, which can be adapted to technical and design requirements, are suitable for this purpose. Their features are short delivery periods, very high concrete quality, and maximum flexibility in the positioning of wall, ceiling and floor openings. The high degree of prefabrication and the short assembly time allow the capital investment needs to be reduced considerably.

Keywords
Farm building, automatic milking system, milking box, prefabricated part

Abstract
Landtechnik 67(2012), no. 3, pp. 205–207, 3 figures, 2 references

Dairy cows are generally kept in loose houses today. Since they naturally live in herds, the animals move freely in the group. Concerning milking technique, automatic milking systems (AMS) are gaining more and more acceptance. Hence, the question arises how the expenses for the construction of milking houses with this technology can be reduced and how the conversion or the extension of the animal houses can be realized more flexibly. The current state of the art in the planning of dairy cattle houses with AMS is the integration of the robot in the animal house in order to keep the distances between the functional areas lying, milking, and eating to be covered by the animals as short as possible. According to the manufacturers, the pipes used to pump the milk from the milking parlour into the tank may be up to 40 m long. Apart from the housed-in AMS with a small office for PC work, which also allows the herd to be observed, all other rooms for the milk tank and the equipment can be located outside of the animal house in a separate building.

One of the advantages of this spatial separation is that the impact of corrosive substances in the animal house air is limited to the robot housing. The rooms for equipment and the tank located outside of the animal house, however, can be built inexpensively and highly flexibly featuring a light design with outside boarding, temperature insulation, and inside dry construction lining, for example. This part of the building may also house other functions and areas, such as calving pens or compartments for sick animals, calves or young animals, storage rooms for feedstuff and litter

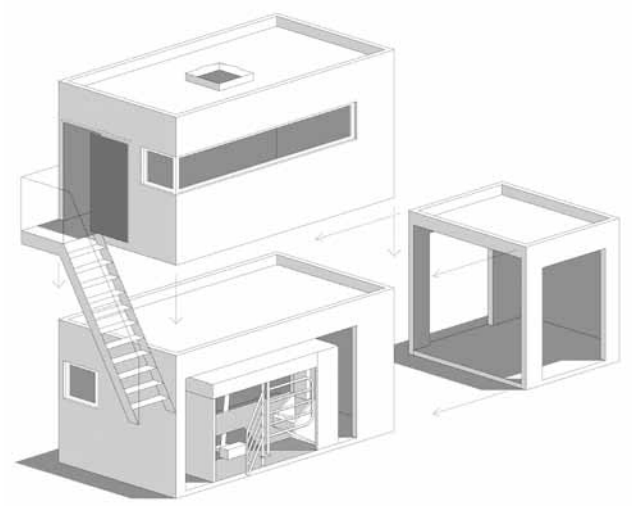
Housing-in of the robot in a modified prefabricated garage

A milking robot compartment based on a modified prefabricated garage was developed in cooperation with a manufacturer of prefabricated concrete parts and the milking equipment manufacturer involved (milking compartment system Grub-Weihenstephan, **Figure 1**). The aim of the project was to save costs, to provide a high degree of prefabrication as well as to optimize construction quality and to increase the flexibility of the animal housing facility.

The milking compartment is manufactured in a factory hall with the aid of a heatable boarding system under the conditions required by DIN EN 13978-1 (garage standard) using concrete of the firmness class C 30/37. Accordingly, a wall thickness of 8, 10, and 12 cm is possible depending on static loads. Given dimensions of 5.50 x 3.48 x 2.83 m, the milking compartment weighs ca. 25 tonnes. Erection time at the construction site is limited to the set-up of a mobile crane for the transfer of the milking compartment to a gravel bed (ca. 4 cm). Since the milking compartment is generally set-up during the shell construction phase, the AMS can be installed later using a hand elevating truck

In addition to evenly high concrete quality, the advantage of prefabrication lies in the preinstallation of all necessary supply lines and potential attachment points for the robot and other

Fig. 1



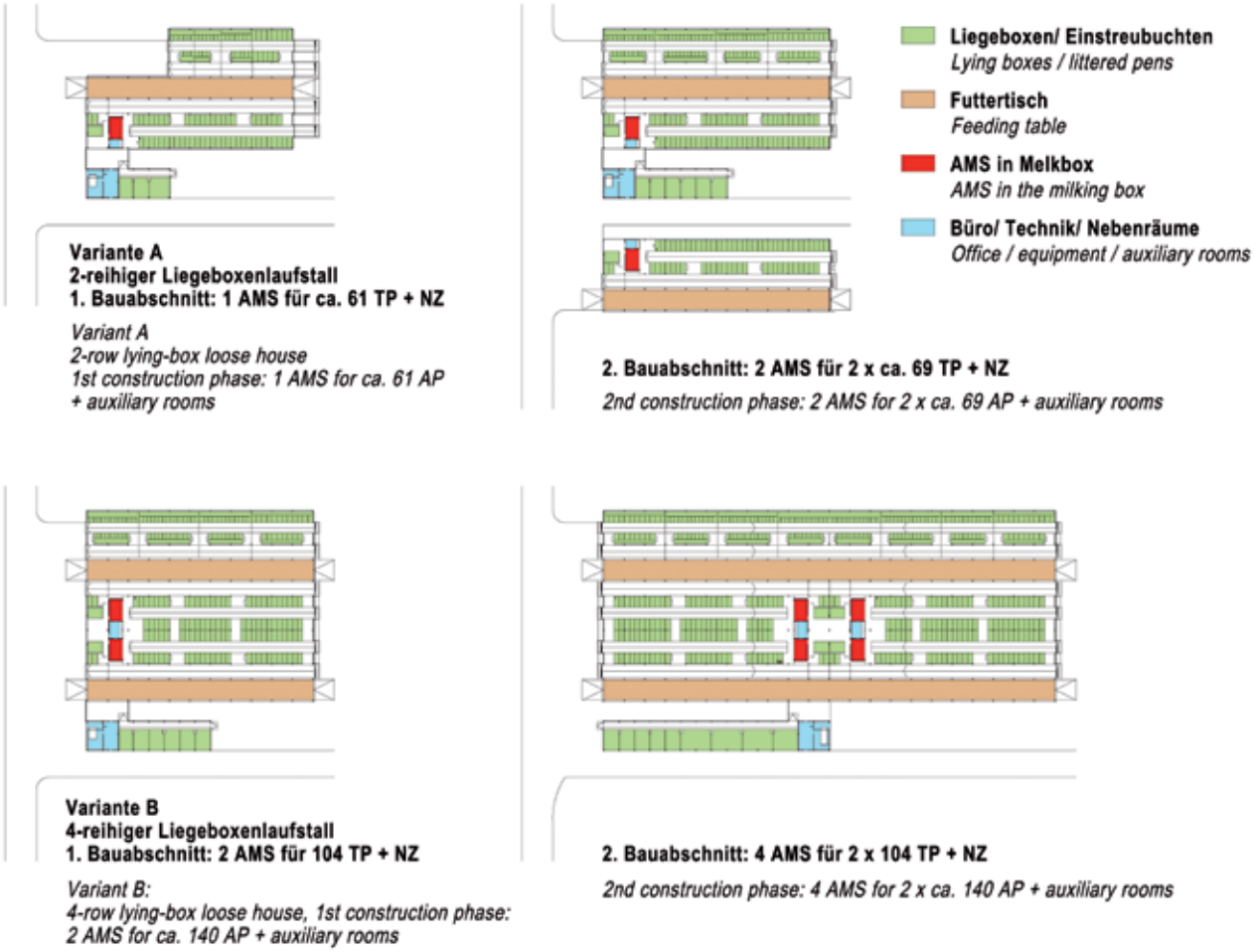
Milking box 'system Grub-Weihenstephan' with an automatic milking system (AMS) and two extension modules (e.g. for an office)

technical equipment in the floor as well as the wall and ceiling plate. The manufacturer involved is insofar different from other suppliers on the market as almost any opening in the wall, the floor, and the ceiling can be realized as required by the plan. Since the boarding systems are installed at a fixed position in the factory hall, the outer dimensions can be changed only within the boarding grid.

If necessary, the ceiling can be used to set up feed concentrate silos. The higher load is compensated for by static measures (reinforcement, thicker walls). Sectional room units, such as a combined milking robot compartment and animal house office, can be built by joining several compartments or by putting one on top of the other.

If the animal house is extended later, it is possible to lift the milking robot compartment out of the animal house with the aid of a mobile crane after the roof has been opened and to reinstall it at a different place in the facility. Thus, the unit does not remain empty when new milking equipment is installed like in conventional milking parlours.

Fig. 2



Planning models with extension steps as an example of the variable use of the milking box

Model plans

Integration into plans shows various arrangement options. Since the arrangement of the functional units milking house (including milk pick-up), feed dispensing, and demanuring including slurry storage depends on the location, these model plans include potential site development. Based on the plans of a pilot farm, variant A (1st construction phase) shows a 2-row lying box loose house with a lying hall, an integrated milking compartment, a separate auxiliary building and equipment rooms, a feed kitchen, and a calf house. This design allows for sectional growth. In order to double the herd size, it is possible to build another lying hall with AMS on the other side of the auxiliary building, which acts as a mirror axis.

Variant B shows a 4-row loose house with 2 AMS in the 1st construction phase as an example. The AMS are first housed on the gable side for site development and most efficient milk pick-up. If it is possible to extend the facility, the self-supporting milking compartment and the light design of the milking equipment rooms would enable the entire milking equipment to be transferred from the edge to the centre of the animal housing facilities (**Figure 2**).

Results

The milking box system Grub-Weihenstephan has already been implemented as a fully functional exhibition unit as part of the instructional show at the Institute of Agricultural Engineering and Livestock Farming in Grub and on a farm (**Figure 3**). The costs vary depending on the size and the equipment. The investment requirements for the model compartment (4.52 x 3.48 x 3.36 m) including a window, various assembly parts, openings, and transport amounted to ca. € 8,500 net. This sum does not include the crane and the costs for the accompanying vehicle. As compared with construction with site concrete or brick (with tile coating on both sides) exclusively carried out by outside companies, construction with prefabricated parts allows up to 45 % of the building expenses to be saved.

Fig. 3

Milking box 'system Grub-Weihenstephan' – exhibition unit on the premises of the LfL in Poing-Grub

The milking box on the farm is directly connected to the animal house and stands at the outer wall on the gable side. So far, no construction measures have been taken in order to insulate or cover the box. Therefore, measuring instruments were installed in order to measure temperature and humidity in the milking box, the existing warm animal house, and the outdoor area. Due to the short operating time and the resulting small data base, it is not yet possible to give a final evaluation of the development of indoor temperature in the milking box. Even during the harsh winter 2011/12, however, no heating was necessary in order to guarantee that the milking compartment remained frost-free. Since concrete has no insulating effect, condensation water formed on the inner side of the outer wall due to the inflow of humid air from the animal house and AMS operation. Later studies will have to show whether passive or active ventilation, higher interior wall temperature due to building shell insulation, or temporary heating can solve this problem.

Conclusions

The prefabricated milking box for the installation of a milking robot promises advantages with regard to transport, flexibility, and installation time. Production in the factory hall provides a high level of size precision, material quality, and, hence, durability. The installation of a complete, self-supporting unit also facilitates its later removal from the animal house. The milking box system Grub-Weihenstephan can be installed in any building type. All in all, this example shows the enormous efficiency of prefabricated concrete parts used for the construction of animal housing facilities.

Literature

[1] Simon, J.; Stötzel, P. (2009): Entwicklung einer Raumzelle in Fertigbauweise für Melkroboter zur Reduzierung der Baukosten. In: Tagungsband zur 9. Internationalen Tagung „Bau, Technik und Umwelt in der landwirtschaftlichen Nutztierhaltung", 21.–23.09.2009 in Berlin. Hrsg.: Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL), Darmstadt, S. 23–28

[2] Simon, J.; Stötzel, P. (2011): Kuh im Kasten. Entwicklung einer Raumzelle für Melkroboter in Fertigbauweise. In: Beton Bauteile 2011, Hrsg. Bundesverband Betonbauteile Deutschland e.V. (BDB), Berlin, S. 128–133

Authors

Dipl.-Ing. architect Jochen Simon is director of the working group Farm Construction at the Institute of Agricultural Engineering and Livestock Farming of the Bavarian State Research Center for Agriculture (LfL), Prof.-Dürrwaechter-Platz 5, D-85586 Poing-Grub.

Dipl.-Ing. (FH) architect Peter Stötzel is a scientist and member of the working group Farm Construction at the Institute of Agricultural Engineering and Livestock Farming of the Bavarian State Research Center for Agriculture (LfL), Prof.-Dürrwaechter-Platz 5, D-85586 Poing-Grub.