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Refurbishing Solid Concrete Floor Surfaces

Development and Evaluation of a Mechanical Refurbishment Method

The skid resistant features of solid concrete floors in loose housing systems for dairy cows have decreased sharply within just a few years. This affects the locomotion, comfort and oestrus behaviour of the animals. Mechanical methods are used particularly in housing systems, where alternatives to expensive rubber coverings are sought. These mechanical methods were not sufficiently geared to animal welfare until now. The refurbishment method recommended here includes the most important aspects involving floor construction, device engineering and for the animals.

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Keywords

Concrete floor surfaces, surface refurbishment, measurement of skid resistance, claw health

In cattle housing systems, solid concrete floor surfaces remain a common solution, with separate function areas such as the outdoor exercise area or the total walking areas made from them. In addition to saving costs, the animal keepers count on eventually being able to refurbish the surfaces using different methods [1]. Although methods such as acid treatment or simple roughening are easy to do oneself as well as cost-efficient, the effect is not long-lasting. In addition to these aspects, animal-related parameters are gaining in importance: the surface structure must be geared to the animals' claws and be easy to clean. From a materials-engineering perspective, refurbishment processes must not damage concrete structure. In the case of mechanical refurbishment methods, this is decisively influenced by the treatment tools and vibratory forces involved.

Development and Optimisation of the Refurbishment Method

In preliminary trials, different refurbishment processes such as sand- and shot-blasting and milling were compared on test surfaces of different ages in existing housing. After this came the development of a combined grooving and roughening method with disk mills making use of various combinations of tools. The selected variant needed to exhibit high skid resistance in both crossways and lengthways directions. In addition, requirements pertaining to the claws were to be incorporated in the best possible manner in terms of dimensions, punctual load [2] and roughness. This is possible thanks to a full-surface treatment in two working stages:

1. Lengthways grooving with round and octagonal milling cutters: distance 20 mm, width 10 mm, depth 3 mm; machine with continuously variable drive for forward movement (*Fig. 1*).
2. Crossways roughening (at an 80º angle to the lengthways grooving) with round milling cutters: distance 8 mm, width 7 mm, depth 1.5 mm; lightweight, manoeuvrable roughening device. (*Fig. 2*)

Fig. 1: Milling device, with continuously variable drives for lengthways grooving. Small picture: Combination of round and octagonal milling cutters

The specific combination of grooving and roughening with appropriate round and octagonal milling cutters enables minimum working depths (3 or 1.5 mm). This is gentle on concrete structure and reinforcement. Commonly used scrapers ensure efficient cleaning. Grooving increases durability in comparison to roughening only. The efficiency of the combined method is strongly dependent on the layout of the different functional areas, and is between 12 and 20 m^2/h. With a working surface area in the region of 150 to 600 m^2 and self-construction work assessed at € 17/h, investments of € 2.2 to € 5.3 per square metre are yielded. Annual costs for a five-year service life come to € 0.5 to € 1.2 per square metre.

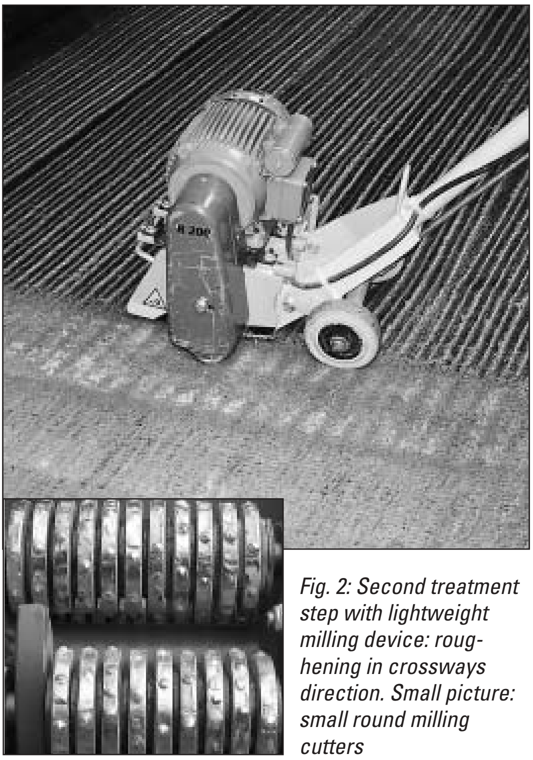

Fig. 2: Second treatment step with lightweight milling device: roughening in crossways direction. Small picture: small round milling cutters

Evaluation of the Refurbishment Process

Method

The method was evaluated on two commercial farms with 35 and 27 dairy cows each. Flooring-related and animal-related parameters were compared before and after the refurbishment in each case. For flooring parameters, skid-resistance was measured with the portable SRT (skid-resistance tester) and the ASRT (adhesion skid-resistance tester). Whilst the spots to be measured with the SRT must be clean and wet, measurement with the ASRT took place right after dung removal. The ASRT was developed in partnership with the DLG Test Center for agricultural machinery. A test body weighing 10 kg is dragged over a measuring length of 350 mm at a constant speed (v = 0.02 m/s). Made of polyamide PA 6, the round sliding disc with a hardness of 73º Shore-D simulates a claw with a diameter of 97 mm and a claw-wall bearing edge of 3/1 mm. Five coefficient-of-friction values per mm are recorded via a load cell and an electronic analysis unit.

The animal-related parameters included behaviour (slipping, comfort and oestrus behaviour) and damage to claws (bleeding, white-line defect). All four claws were visually appraised in the uncut and cut states, separately for inner and outer claw. Slipping and claw parameters were compared with the sign test.

Flooring Parameters

Thanks to the refurbishment, dynamic-coefficient-of-friction values (μ dyn) rose on average by approx. 0.05 μ from 0.21-0.29 μ to 0.27-0.32 μ. On their own, however, the mean values and standard deviation are not meaningful enough. Displaying the dynamic-coefficient-of-friction values in categories enables a substantially differentiated assessment of the treatment effects (*Fig. 3*). There are high correlations between the results in lengthways and crossways directions for both the dynamic and static coefficients of friction. The two-step treatment of the entire area therefore achieves an improvement in skid-resistance.

Animal-Related Parameters

After refurbishment, slipping when walking on the floor surfaces in the feeding area fell significantly on both farms (p = 0.004 and p=0.039, respectively). Oestrus behaviour was improved. Examination of the claws did not point to a rise in the incidence of claw damage, due to the mechanical roughening and grooving of the housing floor surface. An increase in cracks in the white line four weeks after refurbishment was no longer detectable after six months; however, we can deduce from this that more intensive refurbishment methods are likely to lead to claw problems.

Conclusions and Prospects

The refurbishment method combining grooving and roughening via milling cutters with low working depths is gentle on the concrete structure and enables efficient cleaning of the walking areas. Even grooving requires devices with continuously variable drives. The method is cost-efficient and do-it-yourself friendly. The higher skid-resistance encourages a more natural and reduces the risk of injuries to animals, as well as helping to prevent, slips and falls among animal carers.

The method presented is not suitable in this particular version for perforated (i.e. slatted) floors, however. Further methods are being tested for the latter within the framework of the research plan.

Literature

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[2] *De Belie, N., E. Rombaut, K. Simoens and J. de Baerdemaeker*: Effect of surface roughness on pressure distributions in the foot-to-ground contact area for cattle. AgEng Budapest, 2002, S. 1-8

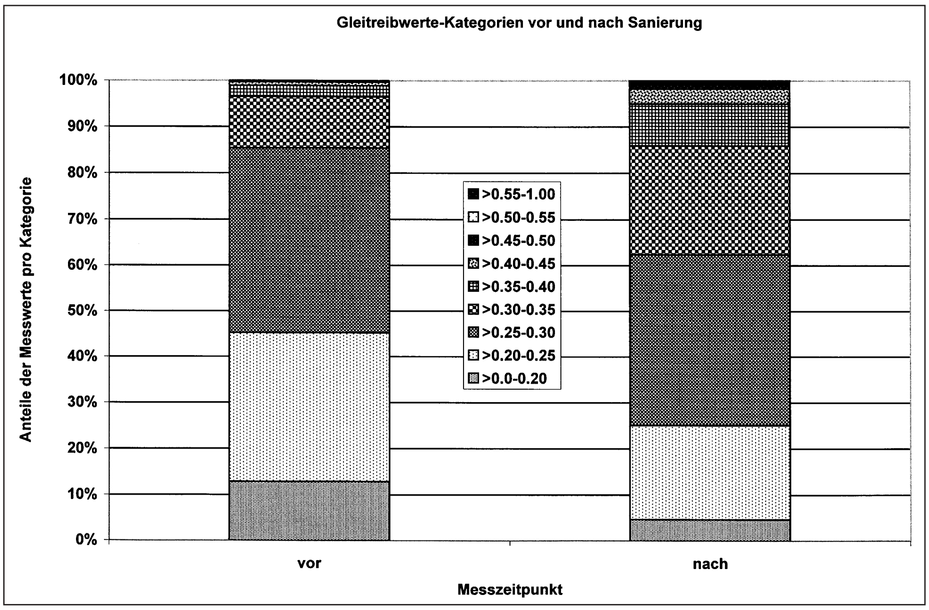

Fig. 3: Categorised sliding friction coefficients show the effects of the refurbishment on the surface-structure