Impact of Flooring on Claw Health and Lameness

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Take Home Messages

- There is an association between exposure of cows´ feet to hard, abrasive flooring and laminitis-related claw diseases causing lameness.
- There is an association between exposure of cows´ feet to unhygienic flooring and infectious claw diseases causing lameness.
- Increased comfortable lying reduces exposure of claws to poor floor conditions.
- Cow tracks, as an indicator of cow walking comfort, were improved with a rubber surface on top of both solid and slatted concrete floors.
- Cows clearly prefer to stand and walk on rubber compared to concrete floors.
- Differences in floor abrasiveness may alter wear and growth that can affect lameness.
- Drier alleyways, by effective drainage of urine and manure, reduce the risk for infectious claw diseases.
- Gradual accommodation of the animals to new floors can reduce the risk for some claw disease.
- Improvements of flooring systems and their management are mandatory to obtain the highest possible animal well-being and performance by reducing lameness and claw disorders.

Introduction

The ongoing process to larger dairy units and the introduction of automatic

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milking systems will increasingly emphasize the importance of reducing risks for lameness since immobile animals will not fit into a system with low labour input. Despite much effort to reduce lameness world-wide, treatments of lameness do not seem to subside. In 1994 the VIII International Conference on Bovine Lameness was held in Banff. Already at this time it was a general assumption that the cows´ feet environment was of primary concern for the outcome of lameness. Hygiene, hygiene, hygiene was the final message to prevent infectious claw diseases. At that time, herd problems with digital dermatitis (DD or PDD) exploded and were blamed as a cause for most lameness problems. Today we know that despite these undisputable DD problems, a great deal of lameness is caused by laminitis-related claw horn lesions such as sole ulcer, sole and white line haemorrhages, white line disease etc. For these diseases the physical environment or traumatic claw lesions are of highest importance. Our experience from the late eighties clearly showed that solid rubber mats in tie stalls reduced the occurrence of laminitis-related sole haemorrhages and sole ulcers. At that stage it was not possible to determine if this was an effect of standing on a soft surface, lying more due to the improved rubber mat comfort or a combination of the two. Fortunately new funding allowed us to test new types of rubber mats on cows´ walking comfort and preferences as well as their influence on claw conformation and claw disease. The research entailed model studies as well as full-scale experimental and field studies with the aim to predict future flooring requirements for cows´ well-being and performance. The main elements were to study: locomotion patterns, cow preferences, hygiene, claw conformation and horn quality, weight distribution between and within claws, lameness, and claw disorders. In this paper the locomotion pattern and preference studies are described and some general aspects on cow comfort are discussed.

■ Laminitis

Laminitis is the underlying cause of many claw disorders and lameness. Laminitis is the name of a complex of claw disorders which we can see in the foot and that often shortens the longevity, reduces the production capacity and causes suffering for animals. Laminitis refers to a non infectious inflammation of the claw corium (laminar corium etc.) harming the horn production. Laminitis has both a metabolic (nutritional) and bio-mechanical (traumatic) background. It is believed that the metabolic component loosens the attachment of the claw bone inside the horn capsule. Provided that the metabolic load is the same, exposure of the cow's feet to hard flooring and improper loading triggers the process. Due to loading and counter pressure from the ground the corium between the claw bone and sole horn is squeezed and blood and blood serum leak out and are absorbed in the growing horn. These hemorrhagic spots are weak points for further environmental damage and are identified as sole and white line haemorrhages, sole ulcers, double

soles and white line disease.

■ Flooring in Dairy Barns

In all types of dairy barns concrete has been the one and only material used for constructing floors for all purposes; lying, standing walking, and working. Concrete is a very good material in many aspects such as engineering, durability and cost. However, concrete as a material is not a given formula because of many differences in compounds and quality; as well, concrete wears and changes with time. Concrete can also be modified to reduce slipperiness by grooving before or after casting. There is no doubt that concrete will continue to be the base for floor construction in the future. But, we already see the development of many different materials to lay on top of concrete for different purposes. Examples are different mats and mattresses for free stalls and rubber mats for alleyways of different quality with the purpose to improve cow comfort and performance. We have tested different patterns of concrete, mastic asphalt, slatted concrete, solid rubber and slatted rubber mats.

■ Tracing Cows with Foot Prints

A new method where the animals' footprints were tracked, measured and analyzed was developed and locomotion patterns for different flooring types were tested in different dairy herds. The track way analysis was also one way of indicating lameness when Canadian researchers evaluated several methods detecting lameness in a recent study (Flower and Weary, 2006). In our first experiment, the cows were tested on five surfaces: solid concrete, slatted concrete, solid rubber mats, slatted rubber mats and finally packed sand. For each surface (except for sand) a 10 m long, straight walkway was prepared with a thin layer of slurry mixed with lime powder. After milking, the cows were kept in a group and individually walked through each surface in one test run. The measurements of the foot-prints were made manually from four consecutive strides on each floor type, using a ruler and an angle-meter (Figure 1). The time of passing each test course was measured to estimate the walking speed of the cow. Cows´ locomotion score was also assessed using the Sprecher method, whether the back was arched when standing and walking.

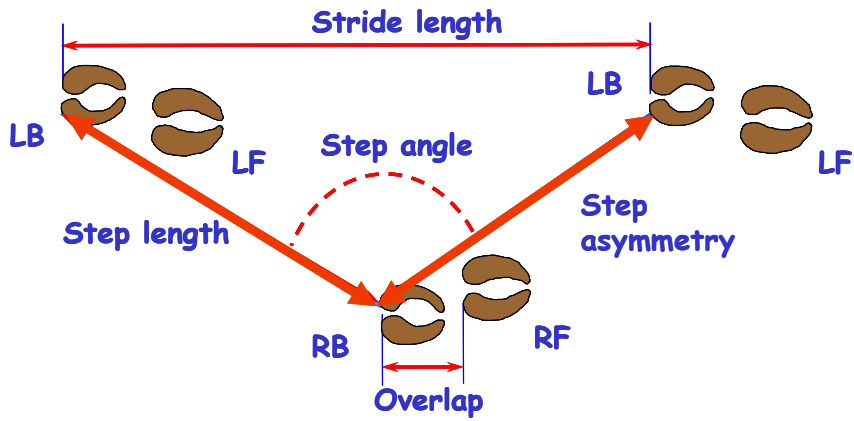

Figure 1. Track way measurements

The results showed that healthy cows walked more efficiently on rubber mats than on concrete floors and both stride and step length increased significantly compared to a concrete surface (Figure 2). The gait pattern was worst for most parameters on the relatively worn concrete slatted floors while natural sand and rubber mats gave the best figures. The speed of cows was lowest on the slatted concrete floor in comparison with the other floor types. On the concrete slatted floor the strides were shortened and the overlap was considerably "more negative" than on the other surfaces. In comparison with slatted concrete, the cows increased their speed, prolonged their strides and steps, and had a higher overlap when walking on the slatted rubber flooring. Cows took longer strides on solid rubber mats than on slatted rubber mats. Other trackway elements did not differ significantly between the two types of rubber flooring.

Although no severely lame cows were present, most cow track way parameters were more pronounced by lameness. Moderately lame (score 2, arched back when walking and standing) cows walked slower than non-lame (score 0) cows, and had a shorter stride and a shorter step length than non-lame and mildly lame (score 1; arched back walking) animals. Moderately lame cows also had a larger negative overlap than non-lame cows. Cows with mild lameness had a positive overlap in contrast to non-lame and moderately lame cows but did not differ significantly from non-lame cows in speed, or stride and step length. Thus slatted concrete resulted in the greatest impairment of gait of slightly lame cows but there was only a very small, non-significant difference between lame and non-lame cows on sand and rubber flooring.

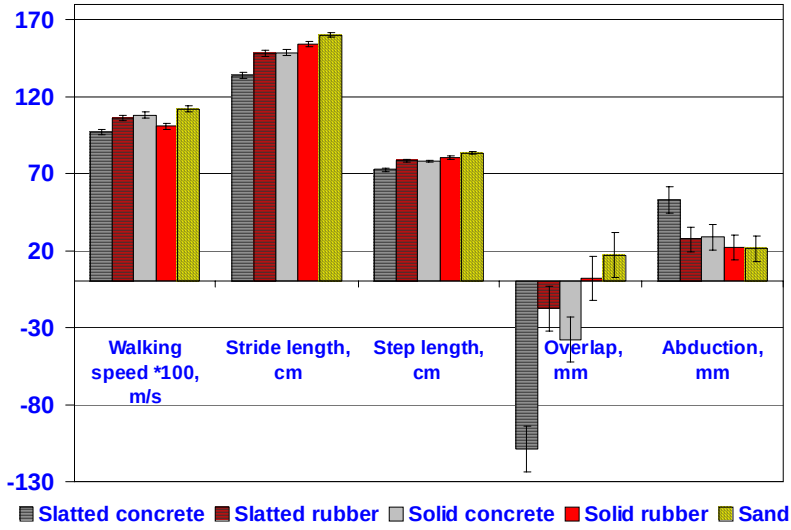

Figure 2. Results of track way analysis of five different parameters when a cow walks on five different floorings

In a second experiment the floor's slipping resistance was judged by the same track way analysis. Slatted concrete and five solid floors (smooth concrete, diamond grooved concrete, hexagon stamped concrete, mastic asphalt and solid rubber mat) of different material and friction were tested after three weeks of accommodation. The results showed that all the solid floors had a better locomotion result than the slatted concrete flooring (Figure 3). Steps were also less asymmetrical on solid floors. The mastic asphalt surface demonstrated significantly higher static and dynamic friction than concrete floors, and elastic rubber mats revealed the highest friction properties. The rubber mats resulted in the longest stride and step length. Strides and steps on smooth and grooved concrete were shorter and closer to that of slatted concrete floor than those obtained on the other floors. Step asymmetry was expressed most on the smooth concrete floor and least on the rubber mats. There was no evidence of flooring influencing step abduction.

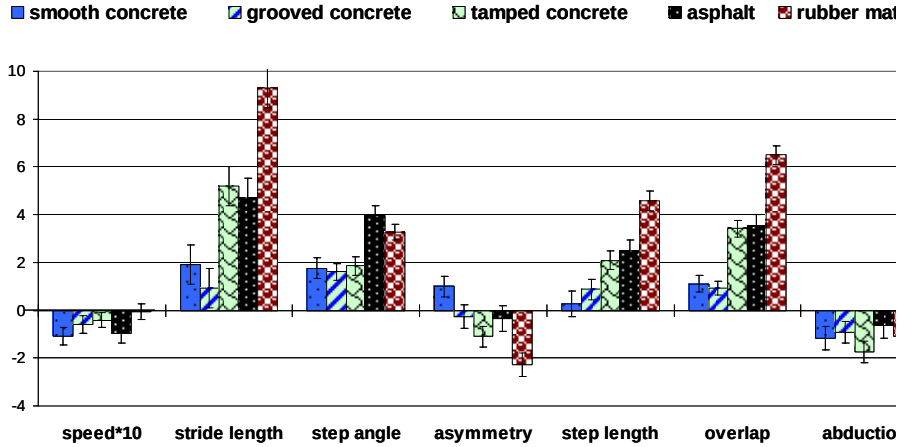

Figure 3. Differences in locomotion between tested solid floors (filled columns) and slatted concrete (baseline)

■ Long Term Influence of Different Flooring Systems

In a three year project 150 heifers were studied from approx. 12 months of age throughout their first lactation in a commercial dairy herd. Claw conformation, locomotion and claw and leg lesions were regularly studied at trimming when housed and at pasture. During the winter housing period before calving heifers were allocated to either concrete free stalls (hard) or deep straw bedding (soft), both with a scraped concrete alley. Heifers on hard flooring had higher growth and wear rate of claws and a higher prevalence of sole haemorrhages and dermatitis than heifers on deep straw bedding. Heifers on hard flooring thereby developed more overgrown claws and heel horn erosion. Leg lesions in the heifers were only observed in the free stall system. All heifers were grazed for 4 months from May and at trimming in September no differences between groups regarding any observed traits were no longer seen. Before their first calving in autumn they were all housed in a free stall system with soft mattresses. Half the animals from each group from the previous heifer housing period were allocated to either concrete slats or rubber slatted flooring in the alleys. After a 4 month lactation period during the winter housing season, the most prominent finding was 3.6 times higher risk for lameness, 2.2 times higher risk for sole haemorrhage and sole ulcer and 2.8 times higher risk for white line haemorrhage in animals on concrete slats compared to those on rubber slats (Table 1).

Table 1. Claw lesions and lameness in first calf heifers on concrete in relation to slatted rubber

Claw Disease	OR	CI 95%	P_{LR}
Heel horn erosion	0.49	0.22 - 1.09	0.08
Dermatitis	1.06	0.44 - 2.52	0.89
Haemorrhages of sole	2.19	1.00 - 4.97	0.05
Haemorrhages of white line	2.82	1.28 - 6.43	0.01
Lameness	3.64	1.33-11.09	0.01

Although not significant, animals coming from deep straw bedding had a higher prevalence of sole haemorrhages and sole ulcers than those from the free stalls, especially when moved to the concrete slats compared to rubber slats. Soft floors are beneficial for cows´ claw and leg health but heifers changing from a soft to a hard flooring system need a longer acclimatization period and trimming of overgrown claws.

Ongoing studies are investigating a new type of alley rubber mat that has an abrasive superficial layer of carborundum to increase wear of the claws and reduce slipperiness.

■ What is the Cow's Opinion on Flooring?

The preference for hard (concrete) and soft (rubber) flooring was tested group-wise in a 300 cow commercial organic dairy herd. Firstly, the preference for soft, extra soft or solid concrete flooring was tested when cows were standing in the holding pen before milking. Secondly, the walkway from the parlour to the cubicles was alternatively equipped with slatted or solid rubber mats or with slatted concrete flooring. The holding pen and walkway were divided lengthwise in two equal parts and each floor type was tested during four days on the left, following by four days on the right side of the holding pen and the walkway respectively. Control treatments were made with concrete flooring on both sides. All behaviour was recorded by video. In the holding pen, the number of cows on each floor was assessed every seventh minute. On the walkway to the cubicles after milking, the number of cows walking on respective floor type or changing between them was assessed continuously from the video.

Dairy cows preferred to stand and walk on rubber flooring compared to concrete flooring. A slightly higher preference for extra soft rubber compared to soft rubber when standing and for solid rubber compared to slatted rubber flooring when walking was observed. When the space per cow increased in the holding pen during milking the proportion of cows choosing rubber mats versus concrete floor increased. With more than 7 m^2 per cow the preference for soft and very soft rubber mats versus concrete flooring was similar and over 70% in comparison to the concrete control. The number of animals choosing soft flooring versus concrete on the walkway increased gradually over time and on the 4th test day it reached almost 80% preference for solid and slatted rubber mats (Figure 4).

Figure 4. Cows showed 80% preference for walking on twenty millimetres thick rubber mats (Gummiwerk Kraiburg Elastik, Germany) compared to concrete.

■ Disadvantages of Rubber Flooring

Certainly, rubber flooring is a more expensive solution, but the question is if there is a return of investment in reduced lameness, decreased treatment cost, better fertility and increased feeding activity, this not including animal wellbeing. From our experiments we could see that claw wear was much less on rubber than on a more abrasive flooring like new casted concrete or mastic asphalt. However, claws seem to adapt to different floors such that less wear is compensated by less growth, and more wear from an abrasive flooring results in more growth. Thus there may be no dramatic differences between old concrete flooring with low abrasiveness and rubber flooring. It is probable that the higher incidence of heel horn erosion on deep straw bedding only is an effect of lower turnover rate of claw horn growth compared to free stalls because the occurrence of dermatitis of the claws was higher in the free stall system. The higher occurrence of heel horn erosion on slatted rubber mats was associated with less draining area compared to the concrete slatted

flooring. This problem can be solved by scraping of the floors with a specific truck (Bobman) or automatically with a cleaning robot or automatic scrapers on top of the slatted floors.

■ General Reflections

Compared to the cow's natural environment when grazing, today's confined dairy systems hardly achieve requirements for comfortable lying, standing and walking; and hygiene is often poor. A higher risk for lameness and leg injuries is found in large and high producing herds especially when housed in a concrete system. There is no indication that production demands will decrease in the future and tomorrow's management systems must thus be planned for even higher outputs than today. On pasture, cows can lie down and rise in a natural way. In dry lots and straw yards, comfort and normal behaviour can be maintained but the hygiene and udder health may be impaired. Free stall systems and tie stalls aim to be more efficient in management and economy but cow comfort and hygiene especially of the foot can be compromised due to poor design and management. If the cow is not comfortable, the artificial confined environment predisposes for environmental diseases of the udder, feet and legs. Cow behaviour can influence lameness indirectly. Foot lesions are related to prolonged standing and walking connected with higher activity due to social interactions and these themselves are related to overcrowding and poor cubicle comfort. Claw injuries are influenced by over-exposure to hard, abrasive and unhygienic floors, while leg injuries, such as hock and carpus injuries, are related to difficulty in lying and rising and prolonged uncomfortable lying on hard, abrasive and unhygienic floors in the stalls. Both experimental and epidemiological studies have revealed more lameness and more claw disorders in free stalls than in tie stall barns and more leg injuries in tie stall barns than in free stalls. The quality of floors, in terms of shape, hardness, friction and hygiene is of great importance for the health of feet and legs. Longer feeding time, larger groups, more frequent milking, and longer walking distance back and forth to the facilities on concrete floors can be contributing factors to excessive wear and overburdening of the claws. The study presented in this paper did not show any significant improvement on track way measurements using concrete with different kind of grooves most probably because all concrete floors compared were relatively newly prepared and the cows were walking in a straight line at a sedate pace without a high risk of slipping. However, mastic asphalt flooring with its higher friction was associated with a more efficient gait. Mastic asphalt will keep its higher friction permanently but our preliminary results showed an over-wear that could be detrimental. Management solutions that facilitate cow traffic and reduce excessive, involuntary standing and walking on uncomfortable concrete floors must therefore be encouraged. Softer and more resilient flooring materials like rubber might be future alternatives in alleys for dairy cows. Feed stalls

equipped with rubber mats are another alternative to improve comfort and hygiene for the feet. In these present studies track way measurements clearly showed the animal's reaction on different floorings, which can be interpreted as a very important indication of the wellbeing for both healthy and lame cows. Moreover the choice of softer flooring is interesting because it is supposed to decrease the risk for claw lesions and lameness. Hard floors and management changes before calving seem to be important factors in the development of subclinical laminitis expressed as sole lesions. An association between concrete floors, sole horn lesions and lameness has also been described in North America. It is obvious that animals can adapt to harsh conditions if they get sufficient time for acclimatization. It is therefore recommended to make changes from softer to harder foundations either months before calving or alternatively to keep animals on soft ground until a few weeks after calving, before introducing them to concrete floors. We should also take into account that harsh abrasive surfaces disturb the balance between outer and inner digits of the rear feet, resulting in an asymmetry between them and a disposition for claw injuries and lameness. Further investigations are in progress.

Figure 5. Cow standing in elevated, divided feed stalls with rubber mats reducing competition and improving foot hygiene and comfort

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