EFFECT OF DIFFERENT FLOORING SYSTEMS ON THE LOCOMOTION IN DAIRY COWS

E. Telezhenko*[1], M. Magnusson[3], C. Nilsson[3], C. Bergsten[1,2], M. Ventorp[3]

[1]Swedish University of Agricultural Sciences, Department of Animal Environment and Health, Skara, Sweden, [2]Swedish Dairy Association, Skara, Sweden, [3]Department of Agricultural Biosystems and Technology, Alnarp, Sweden

Introduction

Floorings in cubicle housing systems for dairy cows are usually made of concrete and have unsatisfying features for unrestrained cattle locomotion in terms of sufficient tractional properties and slipping risks (Van der Tol et al., 2005).

The slipping risk on the concrete floors might result in higher falling risk and injuries both in cattle and people working in the barn. The slippery floors impair the movement in cows (Phillips & Morris, 2001; Telezhenko & Bergsten, 2005), reduce their normal activity (Zeeb, 1987, Benz, 2002) and could be a constant stress factor during locomotion. Presence of manure on the floor constitutes not only hygienic problem but also a high risk for slipping. Analysis of slipping accidents in industrial buildings showed that in 80 % of the cases, the floor covering was soiled (Grönqvist & Roine, 1993).

New types of flooring are now introduced for loose housing in dairy cattle but there are almost no studies on how they interact with slurry in term of slipping risk and how those floors affect the locomotion in the long run. The aim of this study was to assess the friction coefficients and evaluate some kinematic parameters on different contaminated floors under field conditions.

Materials and methods

Animals and floors. 81 Swedish Holstein cows were kept on different floors on the passageways but otherwise under identical management conditions. The floors were solid acid resistant mastic asphalt, continuous elastic rubber mats (KURA-P ™, Gummiwerk Kraiburg Elastik GmbH) and slatted concrete floor. All the solid floors were scraped eleven times per day.

Floor friction assessment. The dynamic coefficient of friction of the different floor materials was measured on different sites of passageways under field conditions, by a testing machine with a test body made of polyethylene (hardness: 95 Shore A) and with the shape of a claw. The test body was vertically loaded with a 200 kg weight and was pulled horizontally along the floor by a hydraulic piston. A load cell placed between the test body and the piston measured the force needed to pull the body along the floor. During the tests the floor was soiled to different extents reflecting typical conditions of the same sites of the respective flooring systems.

Locomotion assessment. A trackway measurement system (Telezhenko & Bergsten, 2005) was used to evaluate cow locomotion on different floors. Locomotion was tested in 33 cows from asphalt floor, 32 cows from rubber floor and 16 cows from slatted concrete floor. The gait analysis was carried out on those sites of walkways with high traffic density, under normal conditions of contamination for the particular floor. The stride length, stride frequency, step asymmetry and step angle were studied. The four parameters from four consecutive strides on each floor were measured with a ruler and an angle-meter. The measurements were assessed repeatedly at three occasions per cow during the housing period. The cows walked at a reproducible speed and no significant changes in speed were accepted.

Statistical analysis. A mixed model procedure was used to analyze the locomotion data (JMP, Version 5, SAS Inst.). The model included lactation number, floor and their interaction. Lactation stage (days in milk) was used as a covariate. Interaction between lactation stage and floor was tested. Random effect for the model was a cow nested within lactation number and floor. The Tukey HSD test was applied for multiple comparisons of least square means.

Results

The slatted concrete floor had the lowest coefficient of friction and the value also had the lowest decrease on more contaminated surface. Rubber had the highest coefficient of friction with low decrease.

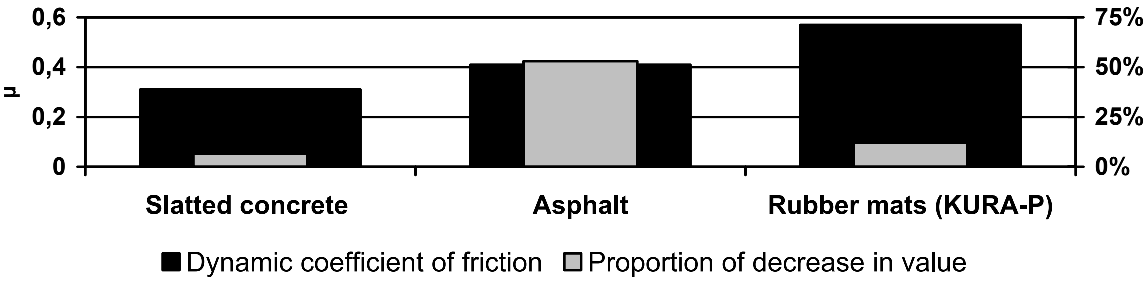

Figure 1. Maximal dynamic coefficients of friction (μ) measured on the contaminated floors and proportion of their decrease on the sites with minimal friction (%)

The asphalt floor showed greatest difference in measured friction – more than 50 % drop in value.

Table 1. Locomotion parameters of cows kept on different floorings

	Concrete slatted floor		Acid resistant mastic asphalt		Yelding rubber mats (KURA-P™)	
	LSM	SE	LSM	SE	LSM	SE
Walking speed (m/s)	1.19a	0.02	1.19a	0.01	1.18a	0.01
Stride frequency (stride/s)	0.80a	0.02	0.79a	0.01	0.74b	0.01
Stride length (cm)	149.14a	2.58	151.64a	1.60	159.82b	1.61
Step angle (˚)	146.37a	2.27	147.26a	1.41	149.78a	1.42
Step asymmetry (cm)	4.93a	0.72	4.86a.	0.45	5.01a	0.46

Values in rows with different letters differ significantly at P<0.05

Cows on the rubber mats had significantly lower stride frequency and longer strides than cows on the asphalt and slatted concrete floors. There were no statistically significant differences in stride length between solid asphalt floor and slatted concrete floor. There were no significant differences in step asymmetry between different floors. Step angle tended to be larger in the group with rubber flooring and less on the slatted concrete, but no statistically significant differences were found.

Discussion

It is important to maintain consistent values of the friction coefficients to avoid higher slipping and falling risk when a cow is passing from a zone of high slip resistance to a zone of low slip resistance. This is why the decrease in the coefficient of friction from one zone to another within the same type of flooring has been evaluated. The highest drop in the coefficient of friction was determined in asphalt floor. It can be explained with the quite rough surface of asphalt, which otherwise provides good friction during walking, but also makes it easier for manure to stay on the floor. On sites of the passageways with low traffic and low wetness, a thin layer of pressed, dry manure was built up. Such sites became extremely slippery in contact with moisture. Scraped surfaces are especially predisposed to such kind of soiling, while unscraped floors are less proned to. That is why there was a very small drop in the coefficient of friction on unscraped slatted concrete floor. The same kind of slippery pressed manure layer was present on the rubber flooring but the drop in coefficient of friction on the rubber mats was much less than on asphalt floor, suggesting that a significant part of slip resistance on elastic rubber mats is determined by the surface deformation under load.

Cows decrease their stride length and increase stride frequency to keep the speed while walking on surfaces with low coefficient of friction (Phillips & Morris, 2001; Telezhenko & Bergsten, 2005). Despite coefficient of friction was in general higher on asphalt floor than on concrete, locomotion patterns of cows walking on the asphalt floor did not show any significant difference with locomotion patterns of cows walking on the concrete slatted floor. That suggested that the high drop in friction coefficient on asphalt floor forced cows to adjust their gait in the same way as on the, on average more slippery, slatted concrete floor. The absence of significant differences in step asymmetry suggested similar degree of adaptation for movement on different floors. Step angle tended to be smaller on slatted concrete and asphalt floor, which might suggest increasing stability of gait by widening the supporting base of walking posture.

Conclusions

It was concluded that cows having yielding rubber mats on the walking areas showed longer steps and lower stepping rate, which are indices of reduced risk of slipping, and therefore demonstrated less constrained locomotion than animals on the hard floors. No differences in cow locomotion were found between the contaminated solid asphalt and the slatted concrete floor under field conditions.

Acknowledgments

This work was carried out as part of the “LAMECOW” project funded through the EC Framework V programme, and by the Swedish Farmers’ Foundation for Agricultural Research.

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