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Effects of Roughness and Compressibility of Flooring on Cow Locomotion

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ABSTRACT

We examined the effects of roughness and degree of compressibility of flooring on the locomotion of dairy cows. We observed 16 cows walking down specially constructed walkways with materials that differed in surface roughness and degree of compressibility. Use of a commercially available soft rubber flooring material decreased slipping, number of strides, and time to traverse the corridor. These effects were most apparent at difficult sections of the corridor, such as at the start, at a right-angle turn, and across a gutter. Covering the walkway with a thin layer of slurry increased frequency of slipping, number of strides, and time taken to traverse the walkway. Effects of adding slurry were not overcome by increasing surface roughness or compressibility. Placing more compressible materials under a slip-resistant material reduced the time and number of steps needed to traverse the corridor but did not reduce slips, and the effects on cow locomotion varied nonlinearly with the degree of compressibility of the floor. Use of commercially available rubber floors improved cow locomotion compared with concrete floors. However, standard engineering measures of the floor properties may not predict effects of the floor on cow behavior well. Increasing compressibility of the flooring on which cows walk, independently of the roughness of the surface, can improve cow locomotion.
Key words: dairy cow, floor, locomotion, welfare

INTRODUCTION

Most research on cow comfort has focused on stall design, but for cows housed in free stalls, flooring surfaces outside the stall are of significant importance. Dairy cows in North America are increasingly housed on concrete floors (USDA, 2002). However, cattle choose to walk on floors that are soft (Gregory and Taylor, 2002) or that provide good traction (Phillips and Morris, 2001). The coefficient of friction of concrete floors is often too low (Phillips and Morris, 2001; van der Tol et al., 2005; Telezhenko and Bergsten, 2005), especially when the floors are covered with slurry (Phillips and Morris, 2000). Adequate traction is especially important when the cow begins to walk, stops suddenly, or turns corners (van der Tol et al., 2005). In practice, the friction of floors usually is increased by grooving concrete floors, and increasing their surface roughness can improve some aspects of locomotion (Phillips and Morris, 2001). Hard flooring can considerably increase the pressure on the cow's hoof (Hinterhofer et al., 2005), however, and research shows that cows seem to avoid grooved, concrete floors (Stefanowska et al., 2002).

Furthermore, concrete floors have been associated with an increased incidence of lameness and hoof problems (Vokey et al., 2001; Somers et al., 2003; Cook et al., 2004). Poor flooring can impair locomotion (Jungbluth et al., 2003; van der Tol et al., 2005), increase the risk of injury (Weeks et al., 2002), and influence expression of estrus behavior (Lopez and Shipka, 2003).

Consequently, there is increased interest in alternative flooring materials for dairy barns, especially floors that have better friction and that are softer than concrete. More recently, a number of rubber-based materials, which also reduce the hardness of the floor, have increasingly been used and tested (Vokey et al., 2001; Fregonesi et al., 2004; Tucker et al., 2006). Although research has shown that cattle prefer softer floors when lying down (Manninen et al., 2002; Tucker et al., 2003), we know little about how the degree of compressibility of the flooring affects locomotion. Recent studies have shown that cows walk faster, walk with longer strides, and slip less often on softer rubber floors than on concrete floors (Jungbluth et al., 2003; Telezhenko and Bergsten, 2005), although the relative importance of surface roughness and degree of compressibility have not been explored. Our objective was to examine the advantages of alternative flooring and the effects of the slipperiness of the surface and the compressibility of flooring on the locomotion of dairy cows.

MATERIALS AND METHODS

Animals and Housing

We used 16 nonlactating Holstein dairy cows (parity between 2 and 6, mean BW = 650 kg), housed in individ-

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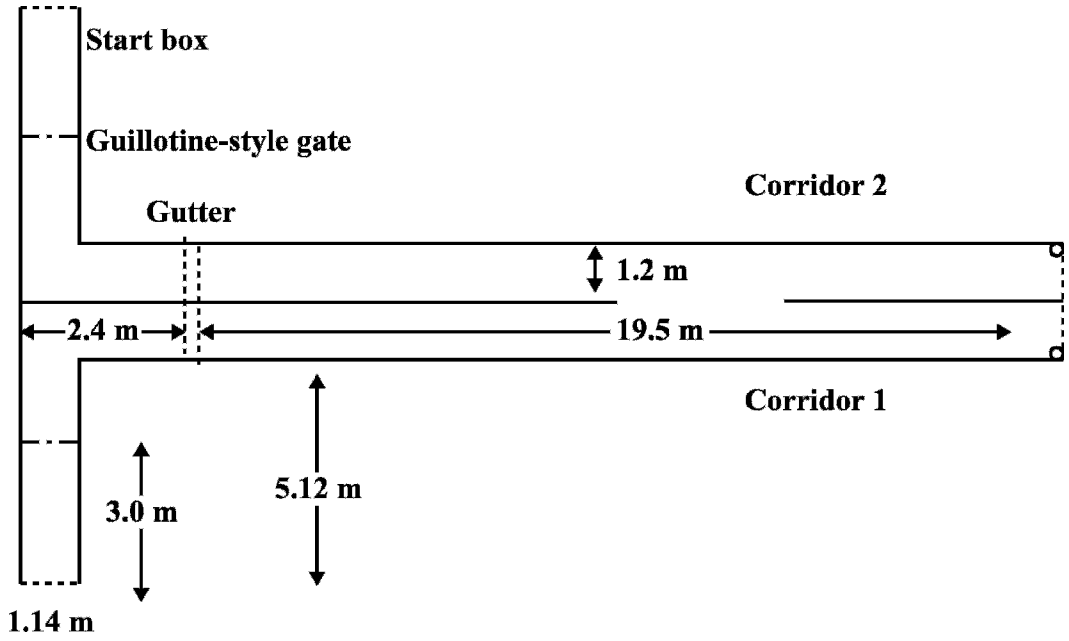

Figure 1. Plan showing the form and dimensions of the 2 walking corridors.

ual 1.4 × 1.9-m tie stalls, covered with PastureMat mattresses (Promat Inc., Seaforth, Ontario, Canada) with a small amount of sawdust bedding. Cows were fed a TMR and normally walked twice daily to the milking parlor. Most walking surfaces were covered with Animat (Animat Inc., Saint-Élie d'Orford, Quebec, Canada), although the cows regularly walked on concrete floors for short distances. The cows were not noticeably lame.

General Procedures and Measures

We examined the locomotion of cows while they were walking down specially constructed walkways with different flooring materials.

Walkways. We constructed 2 special L-shaped walkways that contained some of the challenges that cows face when walking (Figure 1). A small gutter, which the cows had to jump over, was placed after a right-angle turn in the corridor. The gutter was about 10 cm deep and was filled with straw. Walkways were in a separate room of the same barn in which cows were housed. Cows had not been in this room since they were calves. The start box had an Animat floor, a guillotine-style gate that could be opened remotely, and open bars that allowed the cows to see the rest of the room. At the end of the passageway was a bucket that contained a small quantity of concentrate to provide a feeding reward for the cows when they reached the end of the passageway. Walls of the walkways, made of iron bars, were open and the walkways were separated by a wire fence that allowed the cow to see the rest of the room. The other flooring throughout the room was ungrooved concrete.

Cows were taken from their home stalls and moved in pairs to a waiting room, which was a room adjacent to the walkways. Cows were taken individually out of the waiting room and placed in the start box of the walkway. The cow remained in the start box for a few minutes, then the guillotine gate was opened. The cows were allowed to move down the walkway at their own speed while the handler followed the cow at a distance of 1 to 2 m. If the cow stopped, the person waited for 2 s. Then, if the cow had not recommenced walking, the handler moved toward the cow and gave her 2 light prods with a pencil. When the cow stopped at the gutter, the handler waited 7 s before encouraging the cow to move. Once the cow had arrived at the end of the passageway, she was allowed to eat the concentrate for 20 s before being returned to the start box. Any feces were removed from the passageway with a shovel. No other cows were in the room.

A total of 5 black-and-white video cameras were placed at various positions in the walkway, and all cameras fed into 2 multiplexers so that multiple cameras filming each position could be viewed simultaneously. Each passage was filmed concurrently by all cameras using a variable-speed video recorder. Videotapes were then viewed at 1/30th of normal speed (~1 frame/s), and when necessary, a frame-by-frame analysis was