The Influence of Surface Properties of Floor Materials on Ease of Cleaning in Production Animal Houses

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Abstract

The conditions of animal buildings require to some extent different properties of building materials than in other buildings. Floor surfaces are of special interest, since they should stand strong mechanical and chemical stress and they should also, when used in laying areas for animals, be as comfortable as possible to lie on. Besides those properties the floors should be easy to clean. As the production units become bigger the time spend to non-productive work as cleaning should be minimized.

Concrete and different kinds of epoxy and polyurethane coatings and compounds with different filling have been tested in laboratory. Friction of dry, wet and dirty surfaces has been measured with different methods. Also the roughness of dry and dirty surfaces has been measured with different methods. The reason for using different measuring methods has been to find out witch of the methods would describe best the desirable properties for floors in animal houses.

On concretes friction and roughness and ease of cleaning on the other hand seem to be opposite properties. With plastics the ease of cleaning is also depending on the surface properties. The cleaning time per unit with plastics is much smaller than with concretes even if the measured roughness or friction is on the same level. Wearing affects the ease of cleaning both on concrete and on plastic surfaces.

Keywords: floor materials, surface properties, cleaning, speed of cleaning, animal production

Introduction
The conditions of animal buildings require to some extent different properties of building materials than in other buildings. Floor surfaces are of special interest, since they should stand strong mechanical and chemical stress and they should also, when used in laying areas for animals, be as comfortable as possible to lie on. Besides those properties the floors should be easy to clean. As the production units become bigger the time spend to non-productive work as cleaning should be minimized.

Concrete has been the most used material on floors for animal houses. The quality of floor surfaces has quite often been bad and has caused problems. To avoid problems caused by the bad quality different kinds of plastic coatings and compounds have been taken into use.

The basic technical solution needed depends on the demands that the stresses in animal buildings lay for floor materials (Figure 1). The desired properties of floor surfaces are influenced by factors of functionality. As the properties of floor surfaces change during the lifespan selection of building materials used becomes very important.

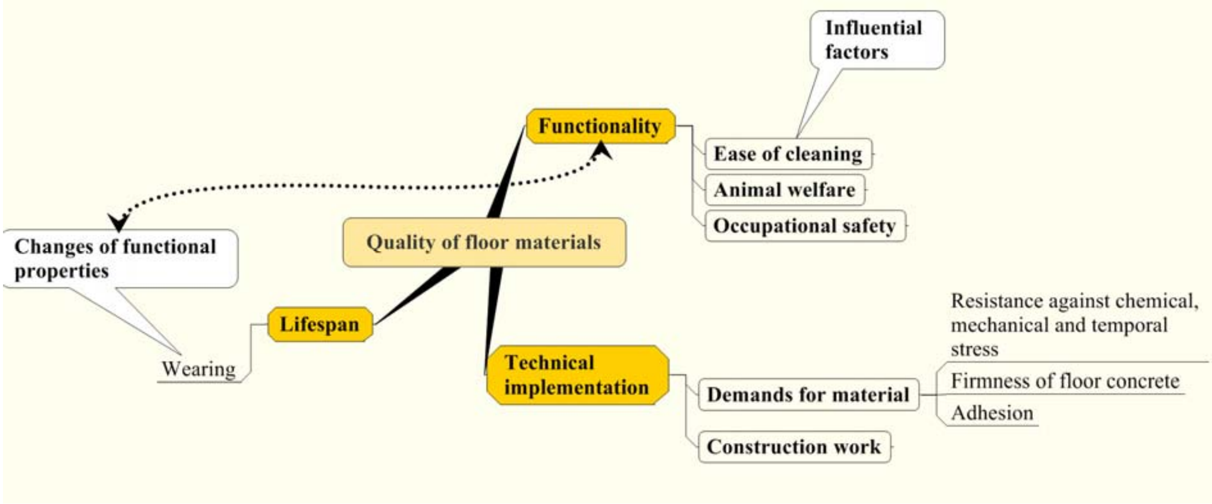

Figure 1: Factors influencing the choice and quality of floor materials.

The aim of our research projects has been to ensure the good quality of floor surfaces in animal houses. In these projects concretes and different kinds of plastic compounds with different fillings have been tested in laboratory.

Material and methods
In the beginning of 1990’s a large project on floor materials in animal houses was carried out. Both concretes and plastic materials were tested. The concretes tested were mixes of different cements and additives with different water-cement ratios. The plastic materials tested were grouped according to the layer thickness as shown in table 1. (Puumala & Lehtiniemi 1993)

All materials went through the same test scheme. The properties tested were:
- resistance against corrosive acid with lactic acid and a silage additive called AIV II (80% formic acid and 2% orthophosphorous acid)
- resistance to abrasion with and without chemical stress
- friction on both dry and wet surfaces when the material was new and when it was a bit worn
- roughness of the material
- ease of cleaning of new surface

Table 1. Groups of plastic products according to layer thickness and the way of coating used in laboratory tests. (Puumala 1997)

Group of plastic products/ number of samples in the group	Average layer thickness	Way of coating
Varnishes / 6	0...20 µm	with a brush on a brick
Paints / 2	40..200 µm	with a brush on a brick
Coatings / 5	0,3...0,5 mm	with a roller on a brick
Compounds / 14	1,5...12 mm	laid on a sheet

For testing ease of cleaning the samples were made dirty with artificial dirt and left to dry up for one day. They were washed up with a washer using a pressure of 75 bar. Distance between the nozzle and the sample was 18 cm and the washing angle 45°. Ease of cleaning was counted as the time needed for the samples to be clean when visually judged. Other testing methods are described in Puumala & Lehtiniemi 1993 and Puumala1997.

During 2004 and 2005 concrete of class K30 as a reference material (marking label F) and five different types of plastic compounds have been tested in laboratory. The plastic compounds tested are described in table 2.

Table 2: The plastic compounds tested in laboratory.

Binding agent	Filled with	Binding agent - Filler Ratio, kg/kg	Marking label
Epoxy	sand, 0,1-1,8 mm	5,3 /18	A
Epoxy and cement	sand, 0,5 – 1,2 mm	3,7 / 2	B
Polyurethane	sand, 0,5 – 1,2 mm	1 / 2	C
Polyurethane and cement	sand, 0,5 – 1,2 mm	5,4 / 2	D
Polyurethane	rubber, 2 – 3 mm	1 / 2	E

Until now the results from slip-resistance and ease of cleaning measurements are available. And only these testing methods are described here.

The slip-resistance of the materials has been tested in laboratory with the method developed at the Finnish Institute of Occupational Health. The friction measurements were performed with a laboratory apparatus (Grönqvist et al. 1989), which simulates human foot motions and forces applied to the floor during an actual slip (the slip simulator of FIOH). Slip resistance is assessed by measuring the dynamic coefficient of friction (DCOF). The slip-resistance of the samples was tested using all polymeric footwear made of polyurethane.

For testing ease of cleaning the samples were made dirty with same kind of artificial dirt as used in previous tests and left to dry up for one week. They were washed up in three different temperatures with a washer using a pressure of 120 bar. Distance between the nozzle and the sample was 18 cm and the washing angle 45°. Cleanliness of test samples was visually judged by two persons with a scale from 1 to 4 (1 = dirty, 2 = quite dirty, 3 = quite clean, 4 = clean).

Results and discussion

Results of the laboratory test carried out in the 1990's with different kind of concretes and plastics are shown in table 3. Concrete surfaces were significantly rougher than plastics. Only some compounds with quartz sand filling reached to the same level. Correlation coefficient between roughness and sliding friction was 0,806 which showed that the tests measured almost the same properties of material surfaces. On concretes friction and roughness and ease of cleaning on the other hand seem to be opposite properties. With plastics the ease of cleaning is also depending on the surface properties but they do not affect cleaning process as mush as with concretes. Concretes had the longest average cleaning times in tests. Plastic compounds even with sand filling and quite rough surfaces were easy to clean.

The average coefficient of friction of plastic compounds and concrete measured from both new and slightly worn surfaces are shown in figures 2 and 3. Although the coefficient of friction decreases a lot on wet and dirty surfaces from that of dry and clean surfaces the measurements with the slip simulator of FIOH showed that all the materials tested were very slip resistance. Only when the surfaces are dirty some of them were classified as slip resistant.

Results from the visual cleanliness of test materials are shown in figure 4. No difference between the ease of cleaning could be found between the different kinds of plastic compounds. Only the cleanliness of concrete was a pit poorer after each washing repetition.

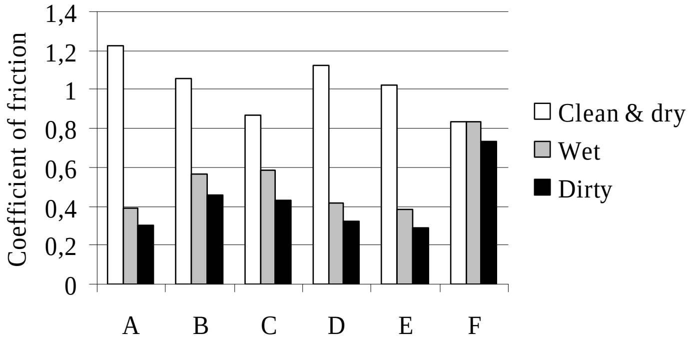

Figure 2: Coefficient of friction of five different new coatings (A-E) and uncovered concrete (F) measured with the slip simulator of FIOH. (average of five blocks)

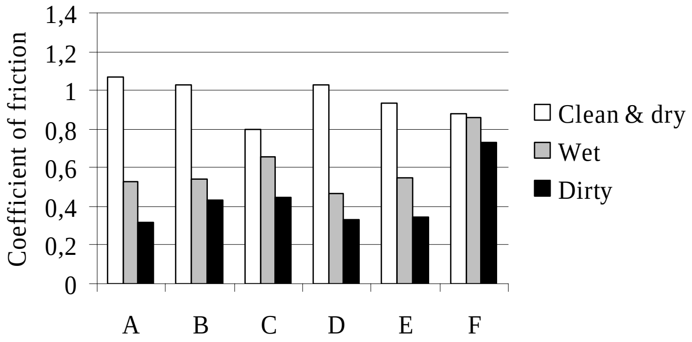

Figure 3: Coefficient of friction of five different coatings (A-E) and uncovered concrete (F) after wearing treatment measured with the slip simulator of FIOH. (average of five blocks).

Table 3. The results of the tested concrete and plastic materials.

Material	Chemical resistance		Resistance to abrasion		Coefficients of friction		Roughness	Ease of cleaning
	plastics in fair or better condition, h or d [1]		measured abrasion, mm		Dry, new surface		New surface	New surface
	Lactic acid	AIV II	mechanical stress	mechanical and chemical stress	Static friction	Sliding friction	Loss of weigh mg	Cleaning m²/h
Concretes[2]	3,04-5,25[3]	3,27-5,10[3]	0,5-1,05	0,6-1,05	0,45-0,51	0,3-0,37	279-369	15-40
Varnish	1 d	6 h	0,2	0,47	0,23	0,14	137	105
Paint	1 d	6 h	0,15	0,45	0,15	0,7	47	97
Coating	1 d	6 h	0,15	0,39	0,19	0,1	31	147
Epoxy compound	28 d	3 d	0,17	0,48	0,31	0,24	71	164
Polyurethane compound	28 d	28 d	0,2	0,32	0,33	0,11	5	120
Acrylic compound	28 d	28 d	0,28	0,31	0,26	0,29	212	210
Special compound	28 d	1 d	0,55	0,75	0,25	0,18	80	145

[1] Plastics were visually inspected and the condition of the surface was expressed by numbers from 1 (poor, useless) to 5 (very good, no changes); fair, coating is partly flaking and slightly soft =3
[2] Variation of 9 different concrete mixtures
[3] Depth of abrasion in mm

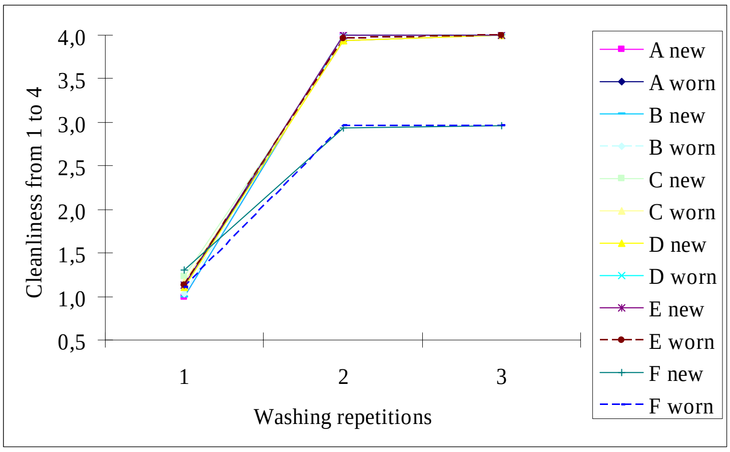

Figure 4: The visual cleanliness of test materials.

According to these result the cleaning time of plastic compounds was significantly shorter than that of concretes. Also thin plastic coatings as well as paints and varnishes diminished the cleaning time compared with plain concrete surfaces. On floors where high standard of cleanliness is desirable use of plastic materials should be considered because they ensure the results with shorter cleaning time.

Literature

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