TEXTILE FLOOR COVERING AS PART OF INDOOR ENVIRONMENT

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ABSTRACT
To be able to compare textile floors to hard floors (linoleum) and their influence on the indoor environment, a project was initiated in an office building. Textile floor covering tiles were installed in four offices. Six similar, neighbouring offices having linoleum flooring were chosen as references. Measurements of airborne particles showed only minor differences between rooms with textile floors and rooms with hard floors. Dust deposition rates were lower in rooms with hard floors than in rooms with textile floors.
The proportions of viable micro-organisms in dust were on average lower in samples from hard floors than in samples from textile floors.

Cost calculations showed that cleaning and maintenance costs are higher for textile floors than for floors covered with linoleum.

INDEX TERMS
Textile floors, Dust deposits, Airborne particles, Micro-organisms, Economic aspect.

INTRODUCTION
Carpets have been claimed to have a negative influence on indoor air quality due to sink-effects and insufficient cleaning and maintenance (Skov et al., 1987) (van Beuningen, Clausen, Pejtersen et al., 1994) (Franke, Cole, Leese, et al., 1997). The National Institute of Technology (TI) has undertaken a verification program focusing on the impact of textile floors on the indoor environment. The intention of this study was to compare the effect of textile floors and hard floors (linoleum) on indoor air quality in an office building.

METHODS
New textile floor tiles were installed in four offices about (10 m^2). Six similar neighbouring offices having linoleum flooring were chosen as references. The offices were cleaned twice a week (Tuesday and Thursday afternoon). The carpets were vacuumed with a vacuumcleaner and rotating brush-nozzle. The linoleum floors were mostly mopped with a dry synthetic mop. Damp mop was used when needed. The test period lasted for one year. After the test period the carpets were thoroughly cleaned by spray extraction cleaning, which has proved to be the most effective method for cleaning carpets (van Beuningen, Clausen, Pejtersen et al., 1994)

For measuring dust deposit rate, there were placed three sampling plates of 250x250mm with a surface of hard plastic in each room 50 cm, 110 cm and 200 cm above the floor. The sampling plates were marked with the room number and L (low), M(medium) and H(high). The measurements were performed every 2nd month. The plates were cleaned after every measurement using a micro fibre cloth. This has proved to be the most effective cleaning method for furniture and fixtures (Nilsen, Dahl, Jørgensen et al., 2002) .

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The amount of dust deposited on surfaces (% area covered by dust) was measured after cleaning and after 2 months exposure by laser extinction meter and gelatinous foils (Schneider, Petersen, Kildesø et al., 1996) (Schneider, Løbner, Nilsen et al., 1994), as described in the internordic standard NS INSTA 800 (Norwegian Standards Association, 2000).

One year after installation of carpets airborne particles were measured with a particle counter (Met-One) measuring total concentration of particles having a diameter d > 0.5 µm and the proportion of non-respirable particles d > 3.0 µm.. Measurements were carried out on two following days at levels 50 cm and approx. 110 cm above the floor. The sampling was done every 15 minutes during the 24 hours measurement periods. Measurements were carried out both before and after extraction cleaning in the rooms with carpets. In the rooms with the linoleum, the sampling was done only once at each level. All rooms were served by the same air handler

Dust depositions on floors were sampled on filters by using a calibrated industrial vacuumcleaner. Samples from carpets were collected both before and after extraction cleaning. Samples from hard floors were collected before cleaning. All samples were taken in traffic areas by vacuuming 1 m^2 of the floor as described in "Indeklimahåndboken" (Danish Building Research Institute, 2000). The amount of dust deposits was measured by weighing. In addition the dust sampled from textile floor coverings and hard floors was analysed at 4-50x magnification in a Wild optical microscope. microbiological analysis of sampled dust was performed at Pegasus Laboratories in Sweden using cultivating and fluorescence microscopy (Bengt Wessén, Gunnar Strøm, Urban Palmgren, 99). Since the number of CFU (colony forming units) is expected to have a logarithmic normal distribution rather than a normal distribution, the logarithm of CFU of the two groups were compared by a Student's two-tailed T-test for two samples.

To evaluate the conditions for microbiological growth after extraction cleaning, the humidity in the textile floor covering was monitored. The sampling started just after the extraction cleaning had ended and lasted until the humidity in the carpet had the same value as the humidity in the air. The relative humidity, % RH, was monitored using a Rotronic Hygrologg D. The Hygropclip sensor was modified by putting a diffusion tight shell having a 3 cm^2 opening around the sensor. The open end was pressed into the textile floor covering immediately after extraction cleaning using a weight of approx. 50 grams.

Calculations of cleaning and maintenance costs for textile and linoleum floors were done by the Norwegian Building Research Institute. The calculations included average costs for spray extraction cleaning of carpets and spray buffing of linoleum floors at recommended intervals.

RESULTS

There were no significant differences between dust deposits rate in rooms having textile floor coverings and linoleum covering, see figure 1.

The average of the dust deposits decreased with increasing distance from the floor. The rates for linoleum floor and floors with carpets were in the same magnitude. The average of the dust deposits for all rooms with carpets and for all rooms with linoleum (hard floors) were:
3,0% on carpet and 2,7% on hard floors (HF) 50cm above the floor (L)
2,6% on carpet and 2,2% on hard floors (HF) 110cm above the floor (M)
2,0% on carpet and 1,8% on hard floors (HF) 200cm above the floor (H)

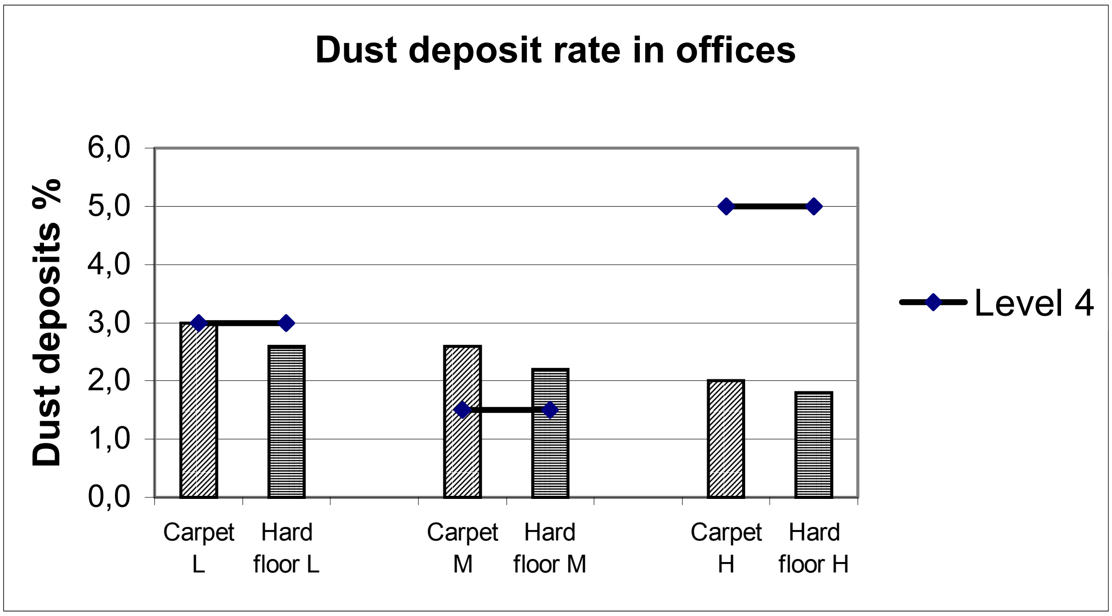

Figure 1. Dust deposit rate in offices (increase in % area covered by dust). Dust on surfaces after 2 months exposure. The bold line shows recomended maximum levels of dust deposits for providing a good indoor environment according to INSTA 800 (Norwegian Standards Association, 2000).

The test results for airborne particles showed that the ventilation system removed much of the smallest particles during the day. When the ventilation system was closed, the total concentration of particles (> 0,5 µm) stabilised on a higher level than during daytime when the ventilation system was on. The larger particles seemed to settled down on the surfaces shortly after the ventilation system was turned off.

It was no significant difference in results for airborne particles between rooms with carpets and rooms with hard floors. The extraction cleaning gave no significant reduction in airborne dust in carpeted rooms. There were however, variations during the test period due to the traffic within and in and out of the room.

The same amount of dust could be removed from carpets by vacuuming before and after extraction cleaning, see figure 2. In some rooms slightly higher values were found after cleaning. This is assumed to be caused by dust being released but not removed by extraction cleaning and hence being more easily removed by the next vacuuming. Half of the readings in the rooms with carpets were above the limit of 0,5 g/m^2 recommended by the Danish Building Research Institute (Danish Building Research Institute 2000).

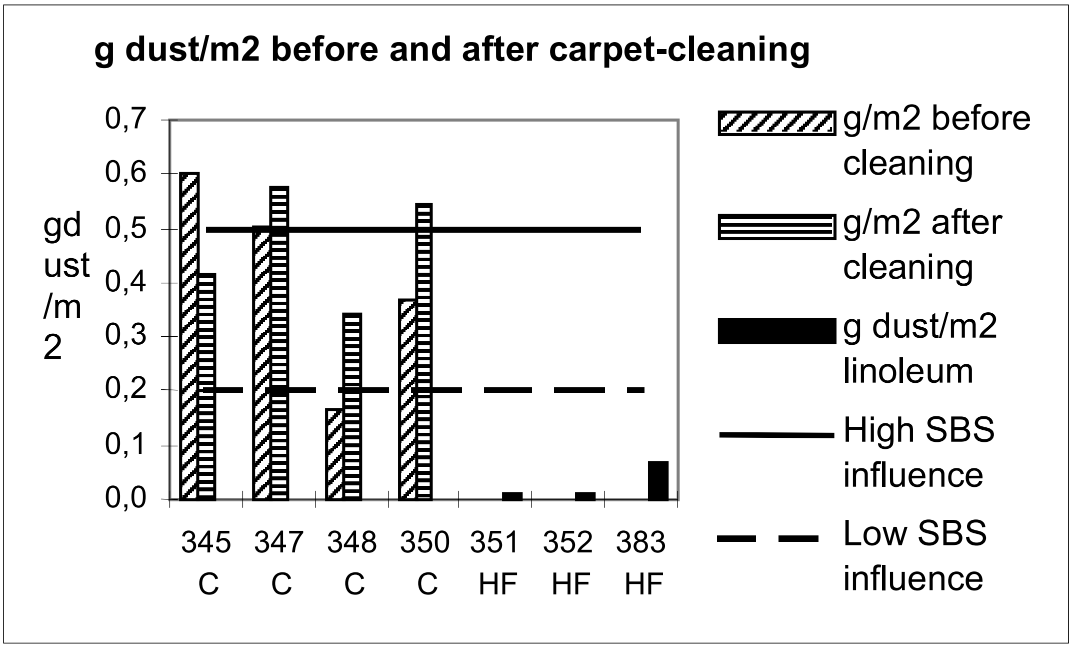

Figure 2. Dust released from carpets by vacuumcleaning, g dust/m^2 before and after spray extraction cleaning. Recommendations given by SBI are showed by lines.

The dust sampled from textile floor coverings (before and after extraction cleaning) and hard floors had the same composition and consisted of: fibres, sand, human skin particles, paper fibres, and floor-polish. Dust sampled from textile floor coverings had a higher fraction of sand and fibre.

The results from the micro-biological analyses of dust sampled from textile floor coverings and hard floors are presented in figure 3.

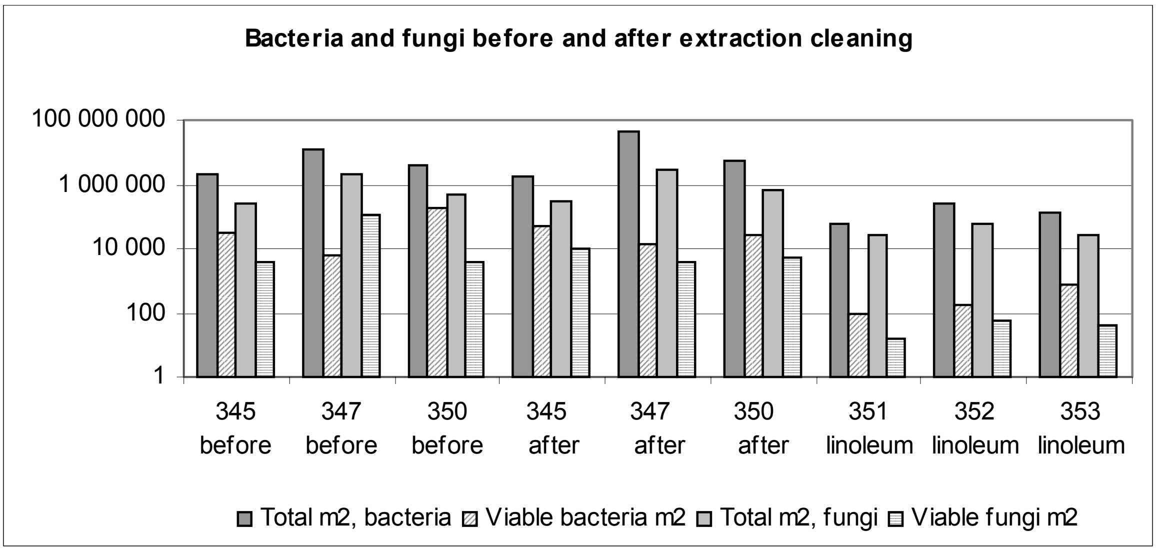

Figure 3. Bacteria and fungi on carpeted floors before and after extraction cleaning compared with linoleum floors before cleaning.

The results varied a lot within each group, and meaningful interpretation was difficult. Extraction cleaning did not significantly reduce the total number of bacteria or fungi per gram extracted dust, but in most cases the proportion of viable micro-organisms was reduced after extraction cleaning. The proportion of viable micro-organisms in dust from the hard floors were on average lower than those having textile floors.

The Humidity control survey started just after the extraction cleaning to see for how long drying time the carpet had after the cleaning. Within 24 hours the textile floor coverings had regained the humidity level of the room air, and a humidity of less than 70 % was reached after 19.5 hours, indicating very low risk of propagation of micro-organisms due to moisture from the cleaning process.

Calculations of costs showed that the cleaning and maintenance costs are NOK 9,90- 12,60 higher per square meter and year for textile floors than for linoleum floors.

DISCUSSION

The results showed that the textile floors and linoleum floors had approximately the same influence on airborne dust and dust settling on furniture and fixtures in the offices. Only minor differences were found. When it came to floors dust deposits were significant lower on hard floors than on textile floors. The proportion of viable micro-organisms in dust from the hard floors were on average lower than those having textile floors. Extraction cleaning did not significantly reduce the total number of bacteria or fungi per gram extracted dust from carpets, but in most cases the proportion of viable micro-organisms was reduced after extraction cleaning. The results shows that carpets can be a dust depot one year after installation despite proper cleaning and maintenance. The results are in compliance with findings of earlier studies (Figley, Makohon and Fugler, 1993) (van Beuningen, Clausen, Pejtersen and Fanger, 1994).

CONCLUSIONS

Textile floors can be a dust depot one year after installation despite thorough cleaning, and can give a slightl contribution of pollutants to the indoor environment which can aggravate the indoor air quality. Textile floors had high dust loading and higher levels of viable microorganisms than hard floor even after cleaning.

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