

The Acoustical Properties of Wool Carpet

“... carpet is one of the most practical and cost-effective products available for controlling noise in the built environment.” Dianne Williams, Graeme E Harding and Associates, Consultants in Acoustics, Noise and Vibration [1].

Carpet improves room acoustics in that it acts as a sound absorber and also dampens any impact noise in a room, such as that arising from footsteps, furniture movement and dropped objects. In contrast, a hard, flat flooring surface is more likely to actually generate impact noise and also act as a sound reflector which, in turn, intensifies the level of noise in a room.

Overexposure to noise can have a negative effect on our health and well-being, the seriousness of which will be determined by the amount and constancy of noise exposure (i.e., the greater the noise and the longer it lasts the worse will be the effects). Results of unwanted noise range from sleep disturbance and impaired concentration to raised blood pressure, hearing loss and a range of stress-related illnesses. Additional effects include loss of productivity in the workplace and learning difficulties in the classroom.

Carpets are one of the few materials that can control noise in three ways: reducing airborne sound, surface noise and sound transmission to rooms below.

Wool carpet reduces airborne sound

Sound is transmitted by the vibration of air molecules. The porosity of the surface of carpets means that sound waves can penetrate into the pile, rather than being reflected back into the room as they would from a smooth surface. Carpets are extremely effective sound absorbers because the individual fibers, pile tufts and underlay have different resonant frequencies at which they absorb sound. In this respect, wool carpets are particularly effective, as the millions of wool fibers in an area of carpet have a range of lengths, diameters, crimps and spirality, which enables them to absorb sounds over a wide range of frequencies (Fig 3 CIAL).

Sound is readily reflected from hard surfaces and the longer it bounces around a room the greater the overall sound level. The resulting reverberation time can vary widely, as for example, around 2 seconds in a public hall or only 0.6 seconds in a well designed office with carpet [2]. The ability of a material to absorb airborne sound is known as its noise reduction coefficient (NRC), which ranges from 0, indicating that all sound is being reflected, to 1 meaning that all sound is absorbed. Noise absorption by carpets has been shown to increase with increased pile height, weight and density [3], while underlay can almost double a carpet's sound absorption performance [4].

While, typically, carpets can reduce airborne noise by 35% [4], in other words an NRC of 0.35, a high pile weight wool carpet recorded an NRC of 0.55 in tests carried out for the US Carpet and Rug Institute (CRI) [5]. In much earlier research, tests of wool carpets of varying construction produced average NRC values of up to 0.46, while with underlay, values of around 0.5-0.7 were achieved [6], which is as good as those of specialized acoustical materials. Sound absorption will be lower if the carpet backing is too impermeable, as it will impede the penetration of sound waves through to the underlay. Cut pile carpet will absorb more sound than loop, because of the more open nature of its surface.

Overall, by reducing the noise levels and reverberation times, wool carpet improves a room's acoustics. Background noises disappear, speech comprehensibility increases and occupants automatically speak in a softer, more relaxed voice, rather than generating even more noise by trying to make themselves heard above the sound around them.

Wool carpet reduces surface noise

Surface noise in a room is the sound from footsteps, dropped objects and furniture movement. Bare tile floors produce 7-12 times more surface noise than carpets [2], which cushion the impact of the noise source, absorbing and deadening the sound. This is achieved by converting some of the high frequencies into less noticeable lower ones. For example, footsteps on concrete create a high proportion of high frequency sound which will be heard as a sharp click or tap, whereas a carpet will change this to a muffled thump. Carpet reduces impact noise by over 20 dB

(decibels), and also ensures that the “life” of the noise is only half as long as that with hard floorings *7]. Again, the thicker the pile, the better the sound reduction.

This type of noise control is particularly important in busy restaurants and other locations where people need to be able to communicate amidst a lot of activity creating a background of continual impact sounds.

Wool carpet reduces noise transmission

While carpets reduce noise transmission through the floor in multi-storied buildings, the degree of actual noise reduction, as well as people’s perception of it, are dependent on the frequency distribution of the sound. So again, wool carpet, because of the fibre’s natural ability to absorb a wider range of frequencies, also provides superior sound insulation for those below.

A material’s ability to reduce noise transmission can be classified according to its impact insulation class (IIC), the higher the rating the more efficient a material is in reducing the sounds transferred to the room below. In the CRI tests mentioned above, wool carpets layed directly on a concrete slab floor-ceiling assembly doubled the IIC value, which was improved by a further 13-18% when varying weights of underlay were also used [5]. (Fig CRI data) Carpet can improve the IIC of common flooring/ceiling systems by approximately 30 dB [1].

Noise from neighboring flats was the second most reported noise annoyance and cause of sleep disturbance after traffic noise reported in the World Health Organization European Health and Housing Survey, 2002-03 [8]. The survey found that adults reporting sleep disturbance had a significantly higher incidence of hypertension, diagnosed depression, gastric and duodenal ulcers, frequent migraine and fatigue. Similarly, children with sleep disturbance problems had over twice the amount of reported migraine/headache problems and a significantly higher risk of respiratory problems than those whose sleep was not disturbed, as well as a 40% increased risk of depression.

The role of carpet in ameliorating the effects of noise generated through normal daily activity has been recognized by the Higher Regional Court Schleswig, which ruled that occupants of apartments who were disturbed by subsonic noise from the flats on the upper floor were entitled

to demand suitable noise reduction measures. The Court was of the opinion that by laying textile floor coverings a subsonic noise of 10 dB could be reached, as required by the German soundproofing standard DIN 4109 [9].

Wool carpet provides superior acoustic insulation

Most of the widely used specialized acoustic insulation materials are generally only designed to tackle one kind of sound reduction, whereas wool carpet can provide equivalent performance with greater flexibility of use.

Soundproofing within the wall cavity will stop sound transmission to adjoining rooms but will not reduce airborne sound in the room where the sound was generated. Similarly, while acoustic ceiling panels absorb airborne sound, they do not reduce surface impact noise. Therefore, in classrooms and other such locations, where good sound reflection from the ceiling will help project the teacher's voice to the back of the class, wool carpet will absorb or isolate other distracting impact noise.

Carpet's multi-tasking abilities also mean that it can provide more all-round acoustic performance than other floorcoverings. For example, while a thick foam-backed vinyl may well muffle footsteps in the room below, those footsteps will still be noticeable in the same room. Carpet, with its ability to both absorb impact noise and reduce noise transmission will provide noise reduction benefits for both rooms.

Trials under practical conditions have shown that the sound absorbing efficiency of even heavily worn carpets was reduced by no more than 16%, while after shampooing, which improves tuft definition, the reduction was only 10% [10]. Wool carpets, which respond well to wet cleaning, would be expected to show an even greater improvement.

Because carpet on walls has the same sound absorbing effect as that on the floor, hand tufted wool rugs not only make attractive wall hangings, but also contribute to noise control. Research has shown that the air gap between the rug and the wall actually increases the noise absorption capacity in the low and medium frequencies [3].

References

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