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SOUND ABSORPTION AND IMPACT INSULATION OF CARPETS AND UNDERLAYS

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Introduction

A range of 10 carpets and 5 underlays has been provided by the International Wool Secretariat for sound absorption and impact insulation measurements. One carpet was made of thin nylon and another was a heavy wool shag but the other eight were more conventional and included tufted and woven types with looped or cut wool pile of varied density and thickness. Of the underlays, two were felt and three were foam rubber.

Separately, measurements have been made elsewhere of the basic properties of the carpets and underlays, such as thickness, overall weight and pile weight.

One of the main objects of this study is to seek simple relationships between the acoustic performance of the carpets and easily measured parameters.

Measurements and Results

1. Absorption

The absorption measurements were carried out on samples of approximately 10 m^2 area in a reverberant room of 224 m^3 volume. All 10 carpets were tested without underlay; then the 5 underlays were tested on their own; finally, 2 carpets, one woven and one tufted, were tested when laid on each of the 5 underlays in turn. In each case the carpet and/or underlay was unrolled and left to settle for some hours on the floor of the reverberant room before testing. The edges were fixed down using double-sided tape, but the carpets were not stretched. Neither were they trampled or rolled before test, so the measurements should relate to the newly-laid situation.

The absorption coefficients of the various carpets, underlays and combinations are too numerous to record here. However, figures 1 and 2 are indicative of the results obtained. It is interesting to note that the carpets alone and the underlays alone all behave in a reasonably similar manner. The absorption coefficient rises with increasing frequency. When the carpets are combined with the underlays, two different types of behaviour emerge. The woven carpet with an underlay gives a combined performance approximately equal to the sum of the individual parts. Absorption rises with frequency tending to a maximum value in the region of 1. The tufted carpet with an underlay behaves quite differently. The absorption is increased at the lower frequencies but at 2000 Hz it is the same as the carpet alone. It is suggested that the sound passes through the backing of the woven carpet into the underlay and the combination behaves as a simple absorbent layer of increased thickness. The tufted carpet may have a backing which prevents direct penetration of the sound wave. Then, at low frequencies, the underlay acts as a damped spring, or cushion, introducing a resonant peak in a broad frequency band. At higher frequencies, the carpet behaves as if the underlay were not there.

* International Wool Secretariat

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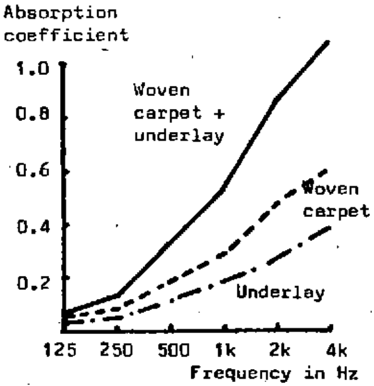

Figure 1

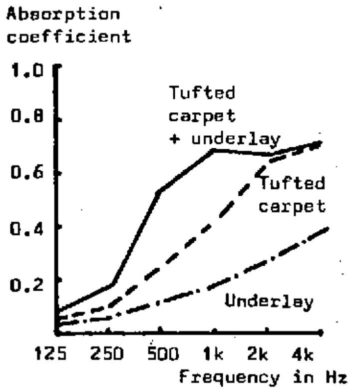

Figure 2

In order to obtain a single figure rating for each carpet, the average absorption coefficient based on the four octave bands centred on 250, 500, 1000 and 2000 Hz has been calculated. Attempts have been made to correlate the average absorption coefficients with various carpet parameters and the most successful is the overall thickness. This is demonstrated in figure 3 which shows a linear relationship.

The regression line is not based on all 25 points. 5 relating to the tufted carpet on the underlays are omitted because their behaviour is not that of a simple porous absorber. The shag carpet is also omitted because its thickness was measured after the carpet had been brushed. The absorption, however, was measured without the carpet being brushed and the thickness during the acoustic test was probably in the region of 22 mm.

2. Impact Insulation Improvement
A 150 mm reinforced concrete floor of approximately 10 m^2 area is set into the roof of the 224 m^3 reverberant room and this was used for the impact tests.

A practical difficulty that arose when either carpets or underlays were being tested alone was a tendency for the covering to flatten and harden as a result of continual hammering. It was observed that the noise spectrum altered considerably during the first few minutes after the tapping machine was switched on but that it had stabilised after about 15 minutes. The covering usually looked compressed and flattened by then. Consequently the machine was allowed to run for 15 minutes before the noise levels were measured.

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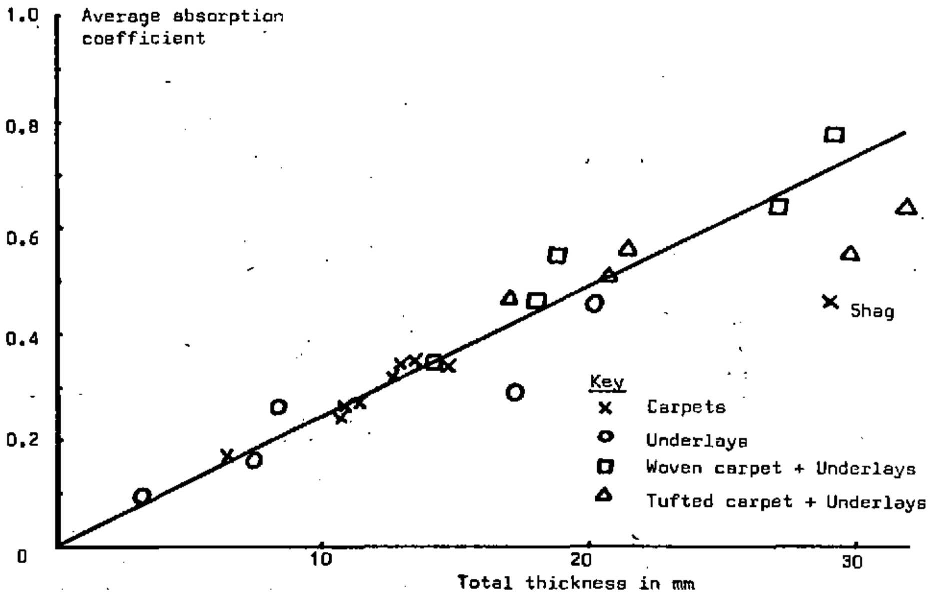

Figure 3

With the carpet resting on an underlay rapid flattening did not occur and measurements were made almost immediately. It was observed in one case that flattening occurred over a period of about 4 hours and that the impact insulation deteriorated over this period but it was not considered practicable, or even desirable, to permit this amount of hammering before every measurement.

Other problems arose during the combination tests because the weight of the tapping machine (supported at 3 points) caused it to sink into the carpet. This made it difficult to maintain the required hammer drop of 41 mm and also made the carpet 'hump' beneath the machine, giving rise to inconsistent results. Finally, these problems were minimised by placing the machine's 'feet' on large flat plates to spread the load and trying to ensure, by observation, that 'humping' did not occur.

The impact insulation improvements of the various carpets, underlays and combinations are all similar in the sense that the III increases fairly rapidly with frequency. Results for the woven and tufted carpets are given in figures 4 and 5.

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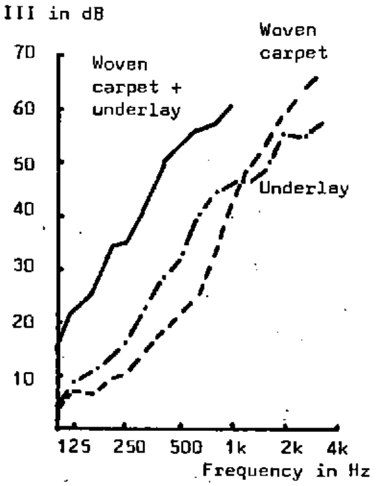

Figure 4

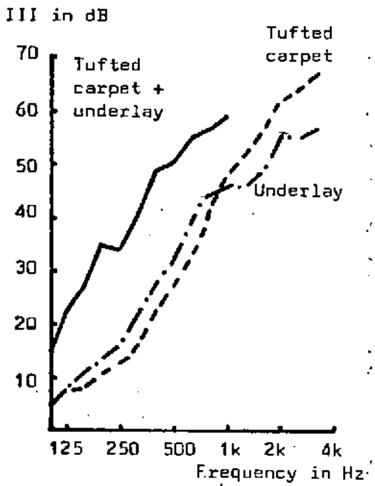

Figure 5

There is no obviously simple connection between the III of the carpet/underlay combination and the III of the individual components. In some instances it seems that the whole is greater than the sum of the parts but this could be due to several things. First of all the combined system is much more resilient than either part alone and the resulting behaviour under impact will be less non-linear. Secondly, the presence of the carpet will tend to trap air in the pores of the underlay, particularly the felts, and so add to the springiness. Thirdly, the tests on the carpet/underlay combinations were carried out after 15 minutes of hammering. No correlation is evident between the average III of the various samples and the parameters which were measured. Physically one might expect the compliance to be a significant parameter but this is not available at this time.

Conclusions

The average absorption coefficient of open or sealed back carpets without underlay, or open back carpets with underlay is linearly related to the overall thickness. Sealed back carpets with underlay do not behave as simple porous absorbers and do not follow the same rules.

No simple relationship has been established between the average impact insulation improvement and the measured carpet parameters. The possibility of correlation with compliance still has to be tested.