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SOUND ABSORPTION IN INDUSTRIAL AND HYGIENIC ENVIRONMENTS

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1. INTRODUCTION

The principles of acoustic absorption as a means of controlling room noise characteristics have been with us now for nearly seventy years, ever since W C Sabine's historic experiments. In practical terms, however, acoustic compromise has often been necessary to balance the many requirements for acoustic control, not least the aesthetic acceptability in relation to the architectural design.

However, by far the most difficult applications for absorption have been buildings whose uses involve sterile or semi-sterile environments. The fibrous characteristics of most traditional absorbing materials have been at loggerheads with these requirements for hygiene. Even where cleaning has not been a major factor, the potential migration of fibres has caused concern particularly in such sensitive areas as operating theatres and computer rooms.

This paper discusses some of the modern methods which have been developed to overcome these traditional drawbacks and gives examples of successful installations where previous solutions would not have been possible.

2. NOISE IN INDUSTRY

Following the introduction of the EEC Directive (Ref.1) 86/188/EEC in 1986, new impetus in the UK and the rest of Europe was given to the protection of workers from the risks associated with exposure to noise at work. In some countries outside the EEC, notably Sweden (Ref.2), the 85dB(A) "action" level was already a requirement. The Noise at Work Regulations (Ref.3) in the UK came into force in January 1990 and required all employers to reduce the risk of noise induced hearing damage to employees to the lowest practical level.

The "Yellow Peril" (Ref.4) introduced in 1972 did much to encourage employers to take action to control the noisiest items of plant. With the lower "first action level" of 85dB(A) $L_{EP,d}$ of the Noise at Work Regulations and the necessity to have proper noise assessments carried out within factories by a "competent person", the need for plant attenuation has widened.

In many cases, the reduction in factory noise levels required to satisfy the requirements of the Noise at Work Regulations are not large and may represent noise from a whole factory or department floor area being affected. The traditional method of treating such areas has been the enclosure of the noisiest machines, with the consequent constraints on maintenance and cleaning, personnel access, ventilation and throughput of material etc. Equally, screens for machines can give some relief for operatives immediately adjacent to the screen, but will do little to control the reverberant component of the noise.

The separation of noisy/quiet machines into different areas would assist considerably with reductions in noise levels. With the gathering pace of automation in industry, where operators mostly supervise activities, the close proximity of production stages is vital for efficient manufacture and separation is now more difficult.

In these cases there is, therefore, the need to control the reverberant sound field as effectively as possible, by the use of large amounts of acoustic absorption. Traditionally this has been applied to wall and roof surfaces, which caused difficulties with existing structural elements, windows, columns etc. and electrical and other services. Retaining the material, usually mineral wool slabs, behind "pegboard", expanded metal etc., also meant that surfaces were difficult to clean and became natural traps for dirt. The use of such facings as "Melanex" to provide some "hygienic" covering also severely restricted the achievable absorption from such areas. In some cases hanging baffles, constructed essentially as acoustics panels of approximately 50mm thick, were used but the enormous weight of these elements (typically around 34Kg/m2) made suspension difficult without the use of sophisticated arrangements. The high load imposed on the roof structure by such panels also restricted the density of such panels, restricting their ultimate effectiveness.

3. NOISE IN HOSPITALS

In the hospital environment noise from both necessary and random activities within the hospital, such as the use of operating theatres, recovery rooms, intensive care and general wards, can cause patient reactions varying from minor distraction to significant sleep disturbance.

Similarly staff, particularly carrying out difficult and complicated tasks, may be distracted, irritated and annoyed, all leading to a loss of efficiency, when they are exposed to randomly fluctuating noise levels.

SOUND ABSORPTION IN SENSITIVE ENVIRONMENTS

In the majority of hospital areas the aesthetic requirements have been completely incompatible with the strict sterile environments demanded. Recovery rooms and operating theatres have always been acoustically hard and "clinical" environments in every sense of the word.

Equally, kitchens and restaurant areas in hospitals also require hygienic environments, particularly given the additional standards required following recent salmonella poisoning outbreaks in a few hospitals and residential homes.

4. THE DEVELOPMENT OF MODERN ACOUSTIC ABSORBERS

Over the past twenty five years a number of manufacturers, notably Ecophon International Limited, have carried out extensive research into viable means of providing finishes to acoustically absorptive materials (usually glass wool) which are aesthetically pleasing, give good levels of absorption and may be cleaned to a level which makes them suitable for hygienic environments.

Initially, research enabled the development of coatings to glass tissue faced, glass wool slabs using special spray techniques. This allowed a highly resilient finish, whilst maintaining broadband acoustic absorption which differed little from the base glass wool slab. This had significant advantages since it enabled the material to be used in traditional exposed or lay-in grid ceiling systems. Advances in manufacturing technology enabled tegular and concealed grid edge systems to be developed, together with the variety of paint finishes now available.

With the development of a special surface finish, about ten years ago a tile system became available which could withstand high pressure wet cleaning without damage or loss of absorption. Naturally, the product name "Hygiene" was chosen to convey its intended use.

There were, however, a number of applications where still higher levels of cleanliness were required, notably in operating theatres, recovery rooms, the manufacture of silicon chips in the electronics industry and sterile dressings, solutions etc. in the pharmaceutical industry. In the past two years this has led to the development of a material known as "Hygiene Advance" which consists of a glass wool base slab, with reinforced web facing encapsulated in a PVF outer covering. This gives very good acoustic absorption figures whilst providing complete sterile protection to the absorptive medium, allowing it to be used in the most demanding locations.

It is interesting to note that the absorption of the product is critically affected by the tension of the PVF external layer and, during the development, direct bonding to the glass wool slab was rejected in order to give the superior levels of absorption now available with the final product.

In addition to the absorptive qualities of these materials, the other most important factor is their weight. As was discussed previously, the use of hanging baffles was, in the past, difficult due to the structural loads imposed. With the use of Ecophon hanging baffles including the Hygiene range, loads are only around 2.5 - 3.5Kg/m2. This allows the standard commercial ceiling grid constructions to be used and, more importantly, the number of baffles can be increased substantially. The loads applied to modern lightweight roof structures are, therefore, generally acceptable to the client's structural engineers.

5. CASE HISTORIES

In order to demonstrate the effectiveness of such materials their use will be discussed in two different environments in the food industry:

Case 1
The acoustic problems with bottling halls are well known to those who have been involved with practical consulting. Long reverberation times and high noise levels in these areas always caused particular problems.

The bottling hall at Becks Bier in Bremen measured 105 metres long by 50 metres wide, with an overall height of 8.65 metres. The lack of acoustic absorption within the space allowed a reverberation time at 500Hz of almost 5 seconds, with low frequency figures of nearly 8 seconds Fig.2 (upper curve).

Ecophon were recommended by Dr. Probst of the Accon Company to supply and install hanging baffles using a special Hygiene product 40mm thick. A total area of approximately 4200 square metres of baffles were installed, some 7000 individual baffles.

The dramatic effect of these baffles is clearly shown in Fig.3 lower curve where, following installation, the reverberation time was measured as less than 1.5 seconds at 500Hz and, even at 125Hz was reduced to about 4 seconds. Similar reductions were noted at higher frequencies. Such reductions can only serve to improve the environment for the work force, whilst improving safety and efficiency from a production viewpoint.

Case 2

The Goman factory in Malmo, Sweden, produces a number of different meat based products for both retail and wholesale outlets. Because of Swedish noise regulations (Ref.2) the factory had committed itself to a five year programme to improve the working environment. The factory is divided into a number of departments making different meat products and these have been treated over the five year period. The original ceiling was a suspended perforated natural coloured aluminium ceiling have Melanex bagged absorbent pads in the rear. The Management had found difficulties cleaning these tiles to the required standard and their acoustic effectiveness was generally considered to be poor.

For the various departments, the company chose the Ecophon Hygiene sealed tile as suitable for their application. The sausage department was the last department to be treated and had an area of around 700m2 containing many noisy machines giving a general noise level of more than 80dB(A). The typical spectrum of this noise is shown in Fig.1 (upper curve). The original reverberation time at about 2.0 seconds is shown in Fig.2 (upper curve).

Following installation of the new Ecophon ceiling there was a considerable improvement in both reverberation time and, consequently, reverberant sound level. These reductions are indicated in Figures 1 and 2 (lower curves) where a reduction of about 6dB is shown across the spectrum, giving a noise level in the area of about 74dB(A) after installation. The above two figures indicate the broadband acoustic absorption available from the Hygiene tile and the very real benefits in both subjective and absolute noise levels within the space.

The above materials are equally useful in the hospital environment where standards of hygiene are possibly more rigorous. The listing in HTM60 (Ref.5) allows their use in operating theatres where, for the first time, absorption is available. The recently completed operating theatre at The Churchill Hospital, Oxford, is an example of its use.

6. REFERENCES

1 Council Directive dated 12th May 1986 on the protection of workers from the risks related to exposure to noise at work (86/188/EEC).

2 National Board of Occupational Safety and Health : Directive No.110 (under review) "Occupational Noise" : Clause 12.

3 The Noise at Work Regulations 1989 (SI1790) : HMSO.

4 Code of Practice for reducing the exposure of employed persons to Noise : Department of Employment 1972 : HMSO.

5 Health Technical Memorandum 60 : October 1986 : DHSS : Welsh Office HMSO.

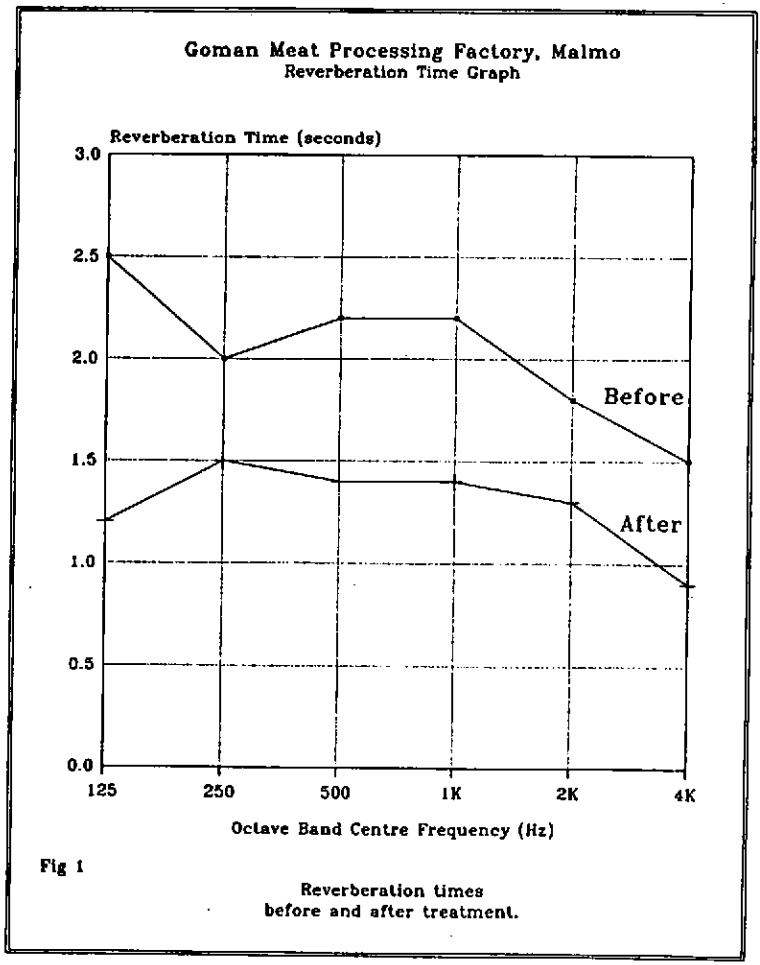

Fig 1

Reverberation times
before and after treatment.

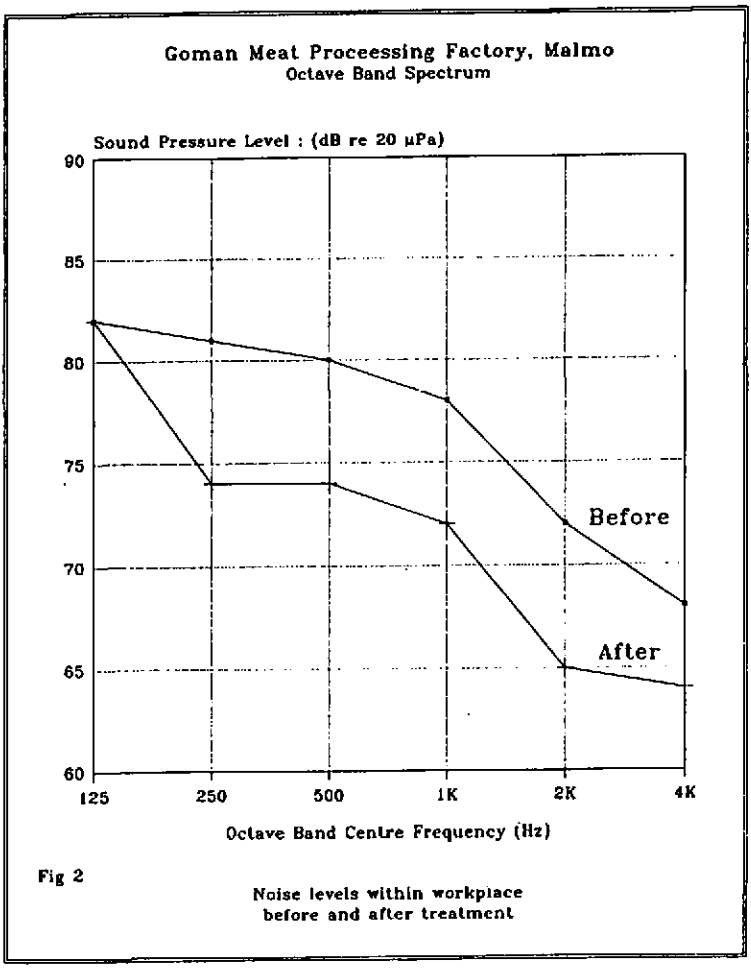

Fig 2

Noise levels within workplace
before and after treatment

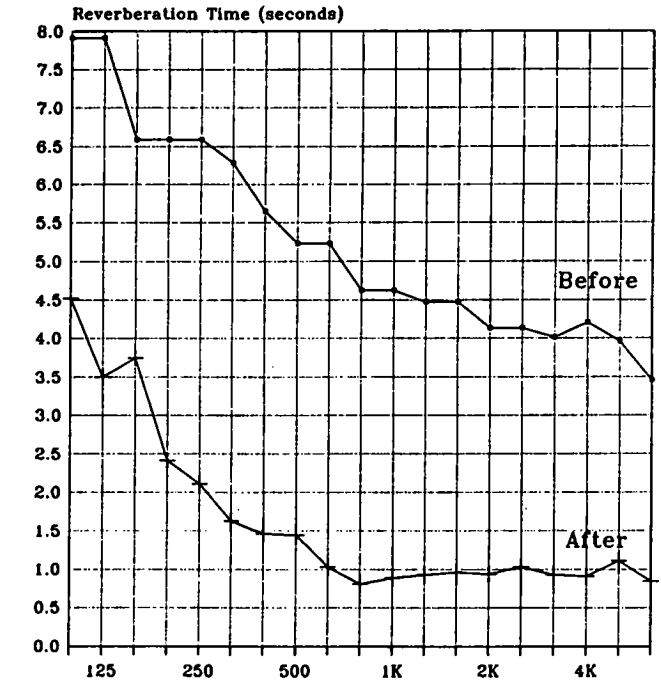

Fig 3

Reverberation times
before and after treatment

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