Sound design

In the Middle East, the air-conditioning equipment that is essential for providing a comfortable internal climate for pupils in schools can also have a massive effect on the acoustic comfort, unless carefully selected.

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Acoustic comfort is arguably the most important requirement of an educational facility. Being able to understand what a teacher is saying is essential to student learning. Education projects are designed to utilise a variety of different environments, invariably with different acoustic demands. Quite often only 50% of the plan area needs acoustic treatment – it is all about specifying the right product without inhibiting design aesthetics and ensuring product durability, says Lianne Peters of SAS International.

Both external noise and classroom 'babble' can affect the performance of students undertaking verbal and non-verbal tasks in the classroom. The introduction of a school grading system by Dubai's Knowledge and Human Development Authority (KHDA) has increased the focus on such pupil performance, with the KHDA's inspection report becoming key to many parents' choice of school. This, in turn, may have a large financial impact on certain schools within the region's primarily paid-for education system.

The problem of noise in schools has increased steadily, with contributing factors including changes in teaching practices, the use of electrical equipment and increasing class sizes. School premises comprise a range of demanding acoustic environments, each with different acoustic challenges. Circulation spaces such as corridors and stairwells can be a source of increased sound reverberation, creating high levels of noise during busy periods. These areas require treatment with sound-absorbent material, which helps reduce acoustic reverberation.

Acoustic baffles and cross-talk attenuators can be designed and installed between classrooms and corridors. Both solutions provide natural cross-flow ventilation, while minimising sound travelling from room to room, thus controlling regenerated noise. In classrooms, durable surface finishes are hard and there-

THE SCIENCE OF ACOUSTICS

The science of acoustics, and its application within buildings, can often be a confusing experience, with a seemingly endless array of different criteria and rating methods. Here we will look at the acoustic issues affecting suspended ceilings. There are two acoustic properties relevant to suspended ceilings, namely sound absorption and sound attenuation.

Sound absorption is a measure of the ability of a surface to absorb sound, minimising the reflection of sound energy back into a space. This is important as a predominance of acoustically reflective surfaces in enclosed spaces, such as a classroom, can lead to an overly reverberant environment; the sound of a single voice can be less intelligible due to the many reflections of sound from the room surfaces. These reflections occur with a time delay compared to the sound energy that reaches a listener's ear directly, and cause the sound to become less clear.

The room characteristic that defines this feature is 'reverberation time' – the length of time (in seconds) that it takes for a sound source to decay by 60 dB. Different environments have differing demands, depending upon the use of the space, and there are differing subjective terms used to describe the different characteristics. Two extreme examples are a radio broadcast studio, where a reverberation time of around 0.2 seconds is required, and the sound is described as 'dry' or 'dead', or a swimming pool with a reverberation time that could be as long as 3.0 seconds, with a 'bright', 'live' or 'reverberant' sound.

Sound absorption is defined as a co-efficient, ranging from 0.0 for total reflection, to 1.0 for total absorption. The sound-absorptive properties of a material are defined in BS EN ISO 11654:1997, which gives three relevant properties:

• Sound absorption coefficient (as): Individual sound absorption figures quoted in third octave frequency bands;
• Practical sound absorption coefficient (ap): Sound absorption figures quoted in single octave frequency bands; and
• Sound absorption rating (aw): A single figure rating based upon the values of ap, compared to a reference weighting curve.

Of these values, the most convenient term is the single figure sound absorption rating, aw, as this allows straightforward comparison between two different products. For most environments, specification in terms of the value of aw will be sufficient. The first two parameters are used by acousticians in the detailed modelling of a space to accurately determine its acoustic characteristics.

BS EN ISO 11654:1997 also introduced the concept of a sound absorption class, with five categories of sound absorption, ranging from Class A to Class E, with Class A offering the higher level of sound absorption. Sound absorption class is roughly equivalent to the value of aw. However, it is more properly assessed by plotting the values of ap against a series of reference curves between 250 Hz to 4 000 Hz.

An alternative and more traditional method of defining sound absorption is noise reduction coefficient (NRC), which is an arithmetic average of octave band absorption over a limited frequency range. This is no longer the preferred unit of choice, as it has been superseded by aw.

Sound attenuation

Sound attenuation is used to describe the reduction in sound between two spaces separated by a dividing element, with two basic sound transmission paths that will affect the eventual perceived sound level difference. Direct sound transmission is the level of sound passing through the dividing element, while flanking sound transmission is the level of sound passing through surrounding structures.

Sound attenuation is measured in accordance with procedures set out in BS EN ISO 140, and defined in BS EN ISO 717. Performance is assessed in terms of third octave band values, with weighted single figure ratings provided to allow ease of comparison. For suspended ceilings, the relevant single figure characteristics are:

Dnfw

Defines the sound insulation value from room to room, where a dividing partition abuts the underside of the ceiling with a plenum (void) above. The laboratory test procedure involves use of a massive partition wall, such that the derived performance is that of the ceiling alone, with no flanking paths.

Rw

This rating defines the level of sound insulation directly through a single layer of material. Whereas Dnfw is a 'double-pass' value, Rw can be considered a 'single-pass' value, although suspended ceilings are rarely tested to determine this parameter.

fore reflect sound easily. Reflected sound increases the reverberation time of the space, making speech less intelligible and learning difficult.

ACOUSTIC LIGHTING RAFTS

Acoustic lighting rafts can be used to meet specific illuminance levels and acoustic requirements. Sound passes through the perforated face of the raft before being absorbed by an acoustic pad. Any sound not absorbed by travelling through the face of the raft but reflected on the structural soffit is absorbed by an additional pad. When used in conjunction with an open soffit, rafts also enable the thermal mass of the structure to be exploited for thermal mass heating and cooling.

Music rooms in schools present an acoustic challenge due to longer reverberation times. Sound levels created by musicians must not be allowed to interfere with surrounding rooms. For recital or performance rooms, the UK Building Bulletin 93 (BB93) suggests a reverberation range of between 1.0 and 1.5 seconds, with an outdoor ambient noise level of no more than 30 dB. The performance for sound insulation between such rooms must have a sound reduction index (Rw) of not less than 45 dB.

Room-to-room attenuation can be achieved using a metal ceiling manufactured to 49 dB. The durable perforated metal ceiling can contain backing pads, acoustic fleece and backing board to meet acoustic requirements. Aesthetic demands need not be sacrificed when specifying acoustic solutions to meet important acoustic legislation. The flexibility of acoustic products allows architects increased design flexibility and durability when considering acoustic settings within the education sector.

For further information visit www.sasint.co.uk MEP

SPECS FOR SCHOOLS

Acoustic comfort: Sound absorption BB93 requirements under Regulation E4 of the Building Regulations for speech intelligibility;
Design aesthetics: Acoustic lighting rafts enable sustainability and natural mass cooling. Modular clip-in or lay-in systems;
Accessibility/maintenance: Secure voids using security clips. Durable, hygienic, wipe-clean polyester powder coated finish. Easy-to-access services;
Durability/sustainability: Durability providing a sustainable solution in terms of the entire cost lifecycle. Recyclable at end of life.