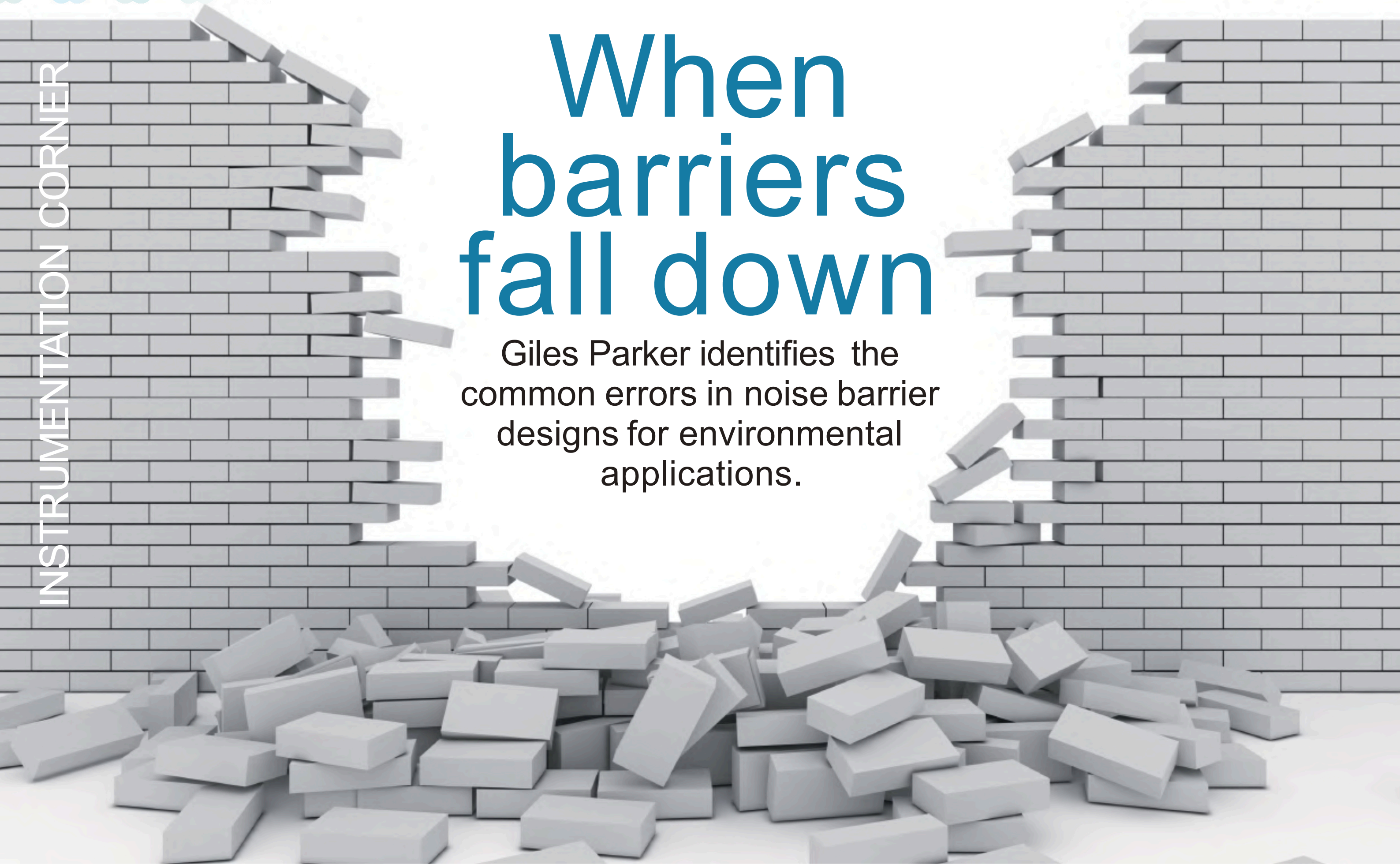

When barriers fall down

Giles Parker identifies the common errors in noise barrier designs for environmental applications.

By Giles Parker, Sound Barrier Solutions Ltd

Some noise barriers fall down because of structural failure. Some noise barriers lose their performance through lack of durability and some noise barriers fail from the outset due to basic avoidable design faults. However, noise barriers correctly designed and specified should work, should last, should stay up and look good.

With 25 years' experience specialising in noise barrier design, we have highlighted below a few of the common errors that may occur at the design or specification stage of a noise barrier scheme for local environmental applications such as to mitigate industrial noise or for housing or commercial developments.

This may be particularly relevant to noise consultants who include barriers in their mitigation designs and to environmental health and pollution control officers tasked with vetting noise impact assessments and mitigation design schemes, whether to control existing environmental noise or as part of future planning applications.

Over-reliance on surface densities

Noise barriers are specified to ensure that sound transmitted through the material surface is negligible compared to the sound diffracted over the top of the barrier. To achieve this, many consultants purely rely on quoting inadequately low values of surface densities such as 10 or 12kg/m² as a 'minimum specification'.

Single-leaf timber barrier panels of 10-12kg/m² may only be 15-18mm thick (based on timber density of 650kg/m³) making for a very thin structure. Tested single-leaf timber barriers typically lose up to 7dB in insulation performance within their first five years due to gaps forming and deterioration. This evidence is covered in the TRL report PPR490 (2010)* demonstrating that relying purely on a basic figure for surface density is wholly insufficient for noise barrier specification which results in timber-based noise barriers under-performing and deteriorating rapidly.

Not specifying road traffic noise barriers

All noise barriers for road traffic noise fall under the Construction Products Regulation (CPR). This is a legal requirement and is just as relevant for housing and commercial development schemes where road traffic is the primary noise source requiring mitigation.

The legal requirement is that the road traffic noise barriers must be specified in accordance with the harmonised standard BSEN 14388:2005 so installing a road traffic noise barrier that does not meet this standard is against the law. BSEN 14388:2005 covers all the test standards that relate to the acoustic, non-acoustic and durability performance characteristics of the noise barrier product. P44

* Transport Research Laboratory: Published Project Report PPR490: 'The acoustic durability of timber noise barriers on England's strategic road network' (Published May 2010) – All barriers tested were installed after 2001, some much more recently. No test report evidence has been published since that counters the conclusions of this study with regard to the deterioration of UK timber noise barriers.

As mentioned above, many consultants merely state low surface densities based on an ancient Department of Transport technical memorandum H14/76 even though it is 50 years old, has twice been superseded and would certainly not be accepted by National Highways for their barrier specifications. It is also worth noting that surface density is not to be found as a required characteristic in the BSEN14388:2005 declaration of performance.

> "All industry standard modelling software (e.g. ISO9613-2) only determines the diffraction loss of a noise barrier and assumes transmitted noise is negligible. In addition to the modelled results, it is therefore important to calculate the transmitted noise component across the frequency range, based on the certificated performance of the barrier."

"We don't specify, we just design"

In their assessments, noise consultants determine if a noise barrier is required, they might calculate the position, length and height of the barrier, and might even state whether it should be absorptive or reflective. If that is all they've been instructed to provide then that's fine. However they would often see it as beyond their remit or skillset to provide a product/ performance specification for the required barrier system.

This presents the client with a problem: They assume the consultant's report has given them enough of a noise barrier specification to proceed, but they find they're left not knowing what to ask for. This creates a 'gap'. When they go out to tender for the noise barrier, they cannot provide any specification requirements for suppliers/installers to meet. As a result, they often end up with inadequate products that haven't been correctly specified acoustically, structurally or for durability.

As an analogy, let's imagine a housing development scheme. The developer-client would rightly expect at the very least, the windows to have a detailed lab-tested sound insulation specification to meet the internal design criteria. What if the consultant ignored that and merely proposed the windows should be made of 'X'mm thick glass? The client would rightly send them back to try again. Consultants, at the very least, should be asking what the client's expectations are.

Tall, thin barrier problems

Having once been asked to review a nine metre high noise barrier design for a waste transfer site, to be constructed from 1.2mm steel sheets, I pondered on its aerodynamic properties and remarked, "that's not a barrier, it's a kite"! Tall, thin noise barriers pose both considerable acoustic and structural problems.

For any noise barrier less than two metres high, most of the noise is passing over the top and the transmission loss through the barrier surface is less significant. As the barrier height rises, the transmission loss become more significant, especially at lower frequencies. For taller barriers of three metres and above, it becomes increasingly important to take into account the transmitted component of noise through the barrier surface. All industry standard modelling software (e.g. ISO9613-2) only determines the diffraction loss of a noise barrier and assumes transmitted noise is negligible. In addition to the modelled results, it is therefore important to calculate the transmitted noise component across the frequency range, based on the certificated performance of the barrier.

Low frequency performance issues

For industrial noise applications, especially where the source of noise has a dominant low frequency component (<200Hz), it is essential that the noise barrier design is not based on a simple broadband analysis. The IS09613-2 methodology allows the designer to calculate the barrier diffraction performance down to 63Hz. Most modelling software extrapolates the calculation method to even lower frequency bands. As a rule of thumb, the noise barrier height should be at least of the same order as the wavelength of the noise source. For example if attenuating an idling diesel train which typically generates high levels in the 40Hz band, a four metre high barrier just won't work when the wavelength is close to nine metres.

Industrial applications tend to have more reflective surfaces – walls, buildings, high-sided lorries, hence absorptive noise barrier designs tend to be optimum choice. It is very important in designing the barrier scheme to characterise the absorptive performance across the frequency range, especially at low frequencies. Most absorptive barrier products significantly reduce in their absorptive performance below 100Hz. So, for an electrical substation transformer, where the 100Hz component is dominant, it is vital to set the absorptive performance of the noise barrier correctly and realistically so that the right specification values can be determined.

Insertion loss/sound insulation mix-up

The airborne sound insulation of a noise barrier product is the reduction in transmitted noise through the barrier surface. This is an intrinsic property of the noise barrier product itself that can be tested in a laboratory with a typical value of 25-30 dB DL_R.

The true benefit of any noise barrier system is the reduction in noise it provides at the noise sensitive receptor which could be a house, say, 50 metres behind the barrier. This difference in noise at the house, with and without the barrier is the insertion loss of the whole scheme. The insertion loss is an extrinsic property of the barrier. In other words, it depends on outside factors; how it is used in that particular scenario, thus it is very site-specific. One would expect this to be of the order of 5-10dB assuming the mitigation design has been done correctly.

A common error is where these two values are mixed up in the barrier specification. We are increasingly seeing suppliers being asked to provide a noise barrier to give, say, an insertion loss of 20 dB (which would be breaking the laws of physics in most practical scenarios). It is important to remember that noise barriers can only be specified on the basis of their intrinsic performance, rather than the extrinsic performance of the scheme which is entirely dependent on its surroundings.

Timber absorptive – geotextile problems

Geotextile/woven polypropylene membranes are commonly used in the construction of absorptive timber noise barriers. The geotextile membrane acts as a structural support/protection for the absorptive mineral wool core of the barrier. However, the intended use of the geotextile product is underground (it's in the name!) Above ground they are prone to rapid deterioration due to UV light. This results in brittling and tearing; forming gaps and leaving the mineral wool exposed to rapid damage. Even with high concentrations of Carbon-Black treatment, their life expectancy can only be increased to five to 10 years (according to geotextile manufacturers).

Noise barriers specifiers and those vetting designs and specifications should view Timber Absorptive barriers with great caution where a durable barrier system is required (e.g. for a housing or commercial development). Other more durable products should be considered. However for some industrial applications, where site use and layout can adapt and change every five or 10 years, timber absorptive barrier remain a viable option as a semi-permanent solution.

Check the maintenance requirements!

The structural and acoustic durability of a noise barrier is directly linked to its maintenance requirements. Noise barriers should be specified for a long (~40yr) life. The need to go back, other than for routine inspection should be unnecessary. From past experience, we would strongly recommend that the manufacturer's maintenance regime is therefore taken into consideration in specifying noise barrier systems. For example, barrier systems that require regular cleaning as part of their maintenance so as to not invalidate the warranty should be treated with caution. This may otherwise go un-noticed and add significant cost to maintain the system to the manufacturer's recommendations.

Similarly, timber barriers that declare a long operational life – assuming the all timber members are replaced on a regular basis – should obviously be refused. Any 'Only Fools and Horses' fans reading this will recognise the 'Trigger's broom' approach being taken here to product maintenance! https://www.youtube.com/watch?v=LAh8HryVaeY

Other issues

Other issues still remain; for example, how to assess the impact of gaps in noise barriers, such as over structures where the barrier weight cannot be supported. Noise models tend to simulate the propagation of steady-state noise and ignore transient events such as the noise of passing traffic propagating though the gaps. Noise models are also limited in how they simulate the diffraction around the ends of barriers. For industrial schemes this is particularly apparent and can result in noise barrier performance being over-estimated, not sufficiently taking into account how sound bends around a vertical barrier edge.

With all the points raised it is vital as engineers to know the limitations of the methodologies and software tools that we use and to understand what is required both of us as designers and specifiers and also to understand the expectations of our clients.

After reading this article you should:

1. Know that all noise barriers for road traffic noise fall under the Construction Products Regulation (CPR).
2. Remember that as a rule of thumb, the noise barrier height should be at least of the same order as the wavelength of the noise source.
3. Most absorptive barrier products significantly reduce in their absorptive performance below 100Hz.