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ENVIRONMENTAL NOISE BARRIERS - M25 WIDENING JUNCTIONS 10-11

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The Environmental Barriers installed on the M25 between Junctions 10 - 11 represent the largest project of its kind installed to date in the UK. The 46,000 square metres of high performance noise barriers were designed to meet the demanding physical, aesthetic and acoustic performances called for by Consulting Engineers, W.S. Atkins. Mowlem Civil Engineering was responsible for the entire £35 million widening project. Radian Engineering was responsible for the supply, engineering, AIP and installation of the noise barriers in conjunction with the main contractor, Mowlem. The Contract began in the early summer of 1994 and is scheduled to be completed by late Spring 1995.

The 8.5 km stretch of motorway between the A3 and the M3 lies in the South Western quadrant of London's Orbital M25 motorway. The carriageway is being widened by converting the existing hard shoulders into traffic lanes and a new hard shoulder has been constructed alongside.

This type of road construction inevitably brings the environmental noise barriers close to the noise source. This means that design criteria needs to take account of insulation value of the barriers as well as the question of reflected noise. The M25 contract called for insulation values of 25 dB(A) between 500 Hz and 5000 Hz. This is a particularly important aspect of the design concept since recent evidence has demonstrated that high levels of noise can pass through traditional lightweight timber barriers.

The Local Authority which borders this part of the M25 is Runnymede Borough Council. Their tireless officials campaigned long and hard for high performance barriers since noise was a major issue even before the widening project took place. Runnymede Borough Council assessed various types of barriers and an investigation was made into the performance of more sophisticated noise barriers than those that were already installed on the M25.

The design of the noise barriers took the Runnymede Borough Council's view into account and not only have high density barriers been specified but also considerable areas of noise absorbent barriers have been installed. Noise absorbent barriers are relatively new to the UK whereas they have been in common use in Germany, Holland, France and Belgium since 1973.

The barrier design between Junctions 10 -11 of the M25 therefore calls for the use of a range of materials which includes stone effect pre-cast concrete, faced with noise absorbent Beton Bois panels, high density Radian System 30 and System 50 timber panels, noise absorbent timber panels and tinted acrylic panels.

The panels are an integrated modular system stacked one above the other between steel posts ranging from 2.4 m to 4.8 m centres. A pattern has been created by varying the position of the modular panels within each bay. The overall effect provides an interesting and pleasing effect on both sides of the barrier whilst giving the residents a high level of protection from the noise of the traffic.

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Road traffic noise is a major issue in the UK and the perceived lack of environmental consideration in road construction has given a platform for a particularly aggressive group of protestors as well as genuinely concerned local residents.

The Government's 'Roads for Prosperity' programme has all but collapsed due to the Department of Transport's reluctance to take on board a pro-active environmental stance. British motorways are overcrowded, the trunk road system is updated in a piece meal way and villages and market towns up and down the country still wait to be by-passed.

So here we have a strange situation. We have a Government which has insensitively battled to acquire planning permission for much needed roads, a general public and industrial community which needs better provision and the whole programme grinds to an ignominious halt largely because of a lack of a coherent Environmental Programme.

It is important to understand the problem in context. British legislation (Control of Pollution Act 1974) introduced a level of compensation to home owners whose properties were being blighted by traffic noise. The provision of the legislation gave compensation to home owners where the noise at the facade of their property reached and exceeded 68 dB(A). The compensation came in two forms, firstly an allowance towards double glazing and cavity wall insulation and secondly a cash payment towards the reduction in value of the property.

A number of problems have arisen directly from this type of legislation. Firstly it creates a 'bunker mentality' in the people who live near noisy roads and railways since their lives are invaded by noise as soon as a window or door is opened. Secondly the very nature of the legislation focuses on solving the problem at the receptor point rather than the source.

Legislation in Germany on the other hand makes no provision for compensation to local residents on the British scale. This means that the noise problem needs to be solved at its source. The advantages are enormous. If the traffic noise can be contained within the motorway itself it means that people who live close by not only enjoy their homes but also their gardens, the walk to the shop and the local parks. The reduction in stress levels is noted by social studies in Germany and resistance to road building is reduced.

Acceptable noise levels are considerably lower in other European countries. For example in Holland where new roads and houses have been planned after 1st January 1982 the limit for the noise level at the facade of a private house is 50 dB(A).

So how are these standards achieved? This takes us back to the M25 Junctions 10 - 11. Since 1990 my own company has introduced a wide range of products and systems which help achieve the high standards of noise control which this project calls for.

We carefully researched the European market and became aware of the technology and systems available to deal with the problems of reducing 90 dB(A) at the roadside to 55 dB(A) a few hundred metres away.

German, Dutch and French systems have two major characteristics - the ability to reduce noise passing through the installed system and the ability to reduce reflected noise. The German legislation which covers noise barriers is controlled at the performance level through ZTV Lsw 88. This legislation covers not only the acoustic performance of the noise barrier but also the physical characteristics of the systems.

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Predictions of noise reduction in other European countries take careful account of the performance of the environmental noise barrier materials. The noise barriers on Junctions 10 - 11 had to meet ZTV Lsw 88 and the AIP process lasted many months.

WS Atkins took account of existing British legislation but also used ZTV Lsw 88 to ensure high standards of acoustic and physical performance. The management of two sometimes opposing design cultures was an extremely demanding task. We had to take account of Technical Memorandum H14/76 - Noise Barriers - Standard and Materials, Departmental Standard BD 2/89 Part 1 and the Specification for Highway Works Series 300. Memorandum H14/76 has been superseded in part by HA 65/94 Design Guide for Environmental Barriers which was produced in December 1994.

Radian Engineering produced 124 drawings for the project as well as submitting tests results for Acoustic Performance, Fire Resistance, Stone Impact Resistsance, Frost Resistance and Timber Preservation. In the case of the acrylic panels additional test results were required for shape retention under load and heat and behaviour after hot air ageing.

It is interesting to compare the Junctions 10 - 11 design philosophy, which essentially is the best of British whilst incorporating proven European studies, with other projects I see coming across my desk.

The British design philosophy is based on CRTN - The Calculation of Road Traffic noise published by the Department of Transport in 1988 and the H14/76 memorandum. CRTN relies heavily on the evaluation of the path difference with and without barriers, without taking account of the characteristics of the barrier material. H14/76 calls only for barrier material to be not less than 10 kg per square metre which equates to 19 mm timber. The H14/76 memorandum also encourages the use of the mass law calculation without taking into account the fact that high frequency noise easily passes through gaps in vertical boarded fences.

Oddly enough Series 300 not only acknowledges the use of lightweight timber fences but actually describes in detail construction methods which allow exposed rails on the traffic face supporting site nailed vertical boards. These unsightly garden fence type barriers have been installed on our motorway and rail systems and produce only marginal benefits.

The breakthrough design of the barriers on the M25 Junctions 10 -11 ensured not only a similar appearance on both sides of the barrier but also barriers with a minimum density of 16 kg per square metre. This time in tongue and groove modular form.

The barrier design on Junctions 10 -11 also takes account of the problems of reflected noise. Jean Pierre Clairbois has delivered several papers on the topic. I first attended a conference in London at the Institution of Civil Engineers in 1990 when the benefits of absorbent and non-reflective barriers were discussed.

The benefits of absorbent barriers have been evident for over 20 years in Europe. It is obvious that the European concept of siting the noise barrier close to the traffic source would cause the noise to be reflected off the face of the barrier. This causes the so called 'ping pong' effect where noise is reflected between the continuous traffic flow and the barrier causing the noise to be carried over the top of the barrier. Jean Pierre Clairblois also introduced the 'canyon effect' where noise is reflected between parallel barriers on opposite sides of the road. The phenomenon is also experienced by residents and the public at tunnel entrances and exits.

In fact any opposing reflective surfaces including retaining walls and high buildings contribute to the canyon effect. Jean Pierre Clairblois also claims that the traffic noise is actually increased due to the energy being contained in a relatively enclosed area.

The design of the barriers on Junctions 10 -11 addresses these important design considerations by the use of absorbent barrier materials where the traffic is particularly close to the barriers and by inclining long runs of barrier at an angle of 10 degrees. Inclined barriers can make a contribution to the reduction of the canyon effect but great care needs to be taken with the site geometry to ensure the planned effect is met.

A variety of noise absorbent materials which meet ZTV Lsw 88 and the new European Standards already exist. The M25 Junctions 10 -11 is using noise absorbent timber panels and noise absorbent Beton Bois cladding material fixed to the traffic face of the pre-cast panels. There are also some display panels manufactured in aluminium modular form similar to the systems erected on the M4 at Junction 5A.

Having solved the problems by reducing noise passing through the barriers and by dramatically reducing reflected noise the designers wanted to reduce the amount of noise passing over the top of the barriers.

In particularly sensitive areas the barriers were increased to as much as 5.0 metres and in one area the barriers were installed at 6.0 metres high. This called for careful design of the barrier foundation. Our company proposed a change in post centres from 2.4 m to 4.8 m which was accepted on a major part of the project. Piled foundations to a depth of 5.5 metres were necessary to carry the calculated wind loads. Barriers on the structures were supported by posts at 2.4 m and 3.0 m centres and were secured to structures using base plates and cast in anchors.

The engineering aspects are of course only part of the story. Such high barriers were considered to be obtrusive especially where the motorway is several metres above the properties of local residents.

The answer was to use transparent material at the top of the barriers to allow more light and to effectively lower the appearance of the barrier. The material specified was acrylic and this has been supplied in a pale bronze tint to discourage bird life from flying into the acoustic screens. The acrylic panels also had to meet the insulation requirements as well as having to comply with ZTV Lsw 88. The consulting engineers also required the acrylic panels to meet BS476 Part 7 1987 which is an additional fire requirement.

Acrylic panels are a popular choice in Europe to allow road and rail users to enjoy a view of the local area whilst residents are not penalised by loss of light. Another benefit of acrylic in an urban environment is the security issue where acrylic panels provide open visible areas for members of the public.

The acoustic performance of the acrylic barrier is enhanced by the use of modular noise absorbent panels at the base of the barrier. This is a useful application on viaducts where barrier heights need to be kept low due to wind loading.

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The Main Contractor, Mowlem Civil Engineering, has been instrumental in introducing a construction option which was accepted by the client. The steep walls of the cuttings were orginally proposed to be retained by sheet piling and gabions. Mowlem's in-house design option of reinforced soil was accepted and around 20,000 square metres of surface area has now been installed. The earth wall contains top soil which has been hydro-seeded and the result is not only attractive but also has good noise absorbent characteristics which complement the entire design philosophy.

The design life of the barrier means that it will be in place well into the next century. Today's designers need to take account not only of today's legislation but also of the increasing aspirations which people have as we reach the millenium.

The new European Standards which will effect UK design are at an advanced stage and have been produced in draft form by a variety of interested groups including the Environmental Noise Barrier Association in the UK.

The new European standards take account of not only the acoustic performance of the barrier but also the physical characteristics of fire resistance, stone impact resistance, secondary safety (falling debris) environmental protection, means of escape in emergency, reflection of light and transparency.

The new standards will give UK residents better protection from traffic noise. The new European standards are in effect virtually the standards to which the Noise Barriers on Junctions 10 -11 on the M25 have been built.