Traffic Noise Mitigation for Sustainable Housing

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ABSTRACT

The recent research undertaken in Australia on traffic noise is reviewed and summarised. The noise from traffic is dependent on a number of variants as it does not remain constant. The variants are volume, speed and quantity of vehicles affecting the noise of traffic; in the main an increase in any one of these variants or combination of the variants will cause an increase in traffic noise. This paper considers the options of noise mitigation for dwellings close to heavy vehicle routes including the possibility for incorporating natural ventilation into housing designs for minimum energy consumption for the Australian context.

KEYWORDS: Traffic Noise and Mitigation

1. INTRODUCTION

Sound is created by the vibration of an object and produces changes in surrounding air pressure, forming a longitudinal wave that is cyclic in nature. These waves move through a fluid medium, in most cases tire and pavement noise moves through air as a medium to create sound. The sound may vary depending on the tread of the tire, texture and density of the pavement along with the speed of the vehicle, which will change the frequency of the vibration, increasing the intensity of sound.

Noise disturbances resulting from road vehicles impacting nearby residences have been shown to result in significant long term health impacts including effects to the cardiovascular, respiratory and musculoskeletal systems as well as through depression, as shown by the 2004 World Health Organisation (WHO) research study, the 2009 WHO Night Noise Guidelines and a recent US study, (Swinburn et al, 2015). The link between environmental noise and the health impact of people living in the residences indicates that significant flow-on economic consequences exist that are to the detriment of the whole community. Effective noise mitigation schemes can be developed for dwellings close to heavy transport routes, however this can be at significant energy costs if not carefully designed.

Main objective of this study is to briefly investigate the causes of traffic noises and options of noise mitigation for dwellings close to heavy vehicle routes including the possibility for incorporating natural ventilation into housing designs for minimum energy consumption for the Australian context.

2. BACKGROUND

2.1 Traffic Noise

Solving the noise problem at the source is generally results in the most beneficial outcome as it will have the flow on effect of reducing noise both inside and outside a building. As shown in Figure 1, the greatest noise produced is that of the contact between pavement and tire friction compared to engine and exhaust noise (Department of Transport and Main Roads, 2011). Bernhard (2004) examined the
vehicle noise produced by different road pavements. Sand asphalt, Rock asphalt and Concrete pavements were investigated and it observed that the noise is depending on the compacts of pavement and it is apparent over 70dBA on grooved Portland cement concrete, rough textured pavements, chip seals and open-graded plant mix should not be used in residential or built up areas that lie close to roads.

![Figure 1. Contributions of the Various Sub-Sources of Highway Traffic Noise (Department of Transport and Main Roads, 2011)](image)

In Asia and Europe, population density is at an all time high causing increased traffic and traffic noise to properties in the tight urban streets. Due to this growing problem a lot of experiments have been carried out to reduce the noise created by pavements. Some general guidelines have been found through experiments (California Department of Transportation, 2011, Department of Environment and Heritage Protection, 2013 & South Australian Government 2014). Surface texture has been found to have a large effect on the noise produced by pavements with length larger than 20mm leading to increased traffic noise; a significant drop in noise has been noticed in pavements with a texture below 10mm. As texturing has been found to have a great influence over the noise produced by pavement, a greater reduction of noise can be found in negative textured pavement types than positive textured ones (Bernhard, 2004). A greater porosity in pavement has also been found to have an impact on pavement noise, specifically aerodynamic noise.

While a decrease in traffic noise is ultimately the desired result, other pavement characteristics have to be taken into account and cannot be sacrificed in order to achieve this reduction. A sacrifice in surface friction and durability can put the safety of road users at risk while an unnecessary increase in the cost could make a quieter pavement unfeasible.

2.1 Australian Traffic Noise Criteria

Sustainable cities involve increasing efficiency land-use, particularly through increasing residential density-of-living. Where higher density re-development occurs in close proximity to major land transport corridors, there is potential for the amenity of future residents to be affected by transport noise.

Sustainable housing focuses strongly on energy efficiency, including preference for natural flow-through ventilation to reduce electricity demand and hence greenhouse gas emissions. A greater number of suitably located windows facilitate reduced energy consumption and provision of fresh air.

Residential development near major transport routes usually involves special acoustic considerations comprising upgraded façade elements including windows. Improved acoustic insulation often relies on windows remaining closed to ensure effectiveness. There is often a conflict between the requirement for natural ventilation and for acoustic amenity within dwellings. Planning and development processes and design standards address both these requirements separately but there appears not to be
suitable information readily available on how ventilation and noise can be addressed through integrated solutions.

3. NOISE MITIGATION TECHNIQUES

As the level of traffic will likely rise with the growing population, it can be assumed that these effects will increase over time. Therefore, a solution needs to be found to significantly reduce the noise produced by traffic either at the source, in transmission or at the receiver.

Tire design is limited by a need to comply with the safety regulations for a vehicle. The design of tires can amplify the effects of pavement and tire contact and may require further research. A safe alternative that complies with safety regulations while reducing the noise produced by friction is the best possible outcome.

Noise barriers come in a variety of shapes, sizes and materials which are dependent on location, safety requirements, acoustic requirements, visual considerations and maintenance. The materials generally vary based on the acoustic requirements and visual aspects of the barriers location. It is preferential to integrate the noise barrier into its natural surroundings with vegetation favoured.

A noise barrier located along a freeway is normally constructed using reinforced concrete, steel or stone/concrete masonry as the safety of vehicles is paramount at high speeds and visual considerations are deemed less significant to the design. The noise barriers along freeways also need to consider the acoustic requirements if passing close to residential areas. As high speed roads such as freeways generate significant noise from high speed traffic flow, traffic volume and heavy vehicles, concrete is necessary to assist in limiting noise transfer. A secondary consideration along busy roads is to design the road barrier to discourage illegal and dangerous crossings by pedestrians along with reducing the likelihood of accidents caused by animals crossing (Department of Transport and Main Roads, 2011). Also, noise barriers can be expensive and are unlikely to produce greater results than preventing noise at the source and the receiver.

The architectural design of a building can have a significant impact on the penetration of noise into the structure where it affects the occupants. Design features such as building height, window size and location along with room placement and courtyard arrangement can assist in limiting the infiltration of traffic noise.

Multi-storey dwellings often have to consider acoustic design more thoroughly than single story buildings due to the reduced protection from barriers and nearby buildings (Vic Roads, 2003). As there is diminished external protection against traffic noise in multi-storey buildings, design techniques and innovative construction methods must be considered.

The best option to consider the acoustics of a house is during the design stage. It is cheaper and easier to design a house to incorporate acoustical properties before it has been built. The use of insulating materials such as concrete or brick with air spaces is a greater noise limiting design than a timber/weatherboard house. A superior insulating material is characterised as nonporous, dense and reflective; while a sound absorbing material is porous with air passages through the interior, these types of materials include glass and rock wool or cellulosic fluff. A combination of insulating an absorbing materials combine the best characteristics of both; the hard insulating material reflects the noise as the outer layer while an absorbing material is placed inside with air space to filtrate the remaining noise (Vic Roads, 2003). The more beneficial method for limiting noise penetration is to replace thin glass with a thicker, glazed window with proper sealing as indicated in Table 1.

<table>
<thead>
<tr>
<th>Possible Noise Reduction (dB)</th>
<th>Type and Thickness of Glazing</th>
<th>Type of Window</th>
</tr>
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<tbody>
<tr>
<td>5 to 15</td>
<td>Any type of window when open (depending on size of opening)</td>
<td>Single Glazing: Closed</td>
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Table 1. Window Insulating Techniques and Possible Noise Reductions (Vic Roads, 2003)
### 6. CONCLUSIONS

Solving the noise problem at the source is generally results in the most beneficial outcome as it will have the flow on effect of reducing noise both inside and outside a building. The greatest noise produced is that of the contact between pavement and tire friction compared to engine and exhaust noise. The potential for greater noise mitigation appears to be likely to come from a pavement solution that can combine the characteristics of a porous and elastic type surface with a pavement that is more endurable. The other area for noise mitigation improvements have to be on the receiving end of the noise through proper housing insulation. The cost of insulating can escalate quickly and research into cheaper alternatives should be encouraged. The proper insulation can have a significant impact on reducing the amount of noise penetration into a building. Proper insulation requires that all doors, windows and cracks be properly sealed; therefore, difficulties have arisen when insulating a building in providing the regulated amount of ventilation. Further designs should be considered when applying ventilation to an insulated building. Insulating a building however, only limits the noise for that singularity and unless it is carried out on a widespread scale is not a complete solution.

Home insulation and pavement design have been briefly focused on in this paper as they provide a wider scope for improvement than other areas, it is recommended that research efforts be applied in these areas compared to other car noise sources or during noise transmission.

### REFERENCES


