ADELAIDE AIRPORT NOISE INSULATION PROGRAM – PUBLIC BUILDINGS

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Abstract

The Department of Transport and Regional Services is overseeing a $63 million federally funded sound insulation program for residential and public buildings surrounding the Adelaide Airport. VIPAC was engaged by the project manager (Clifton Coney Group) as the acoustic consultant to design the treatments for the buildings, to oversee the installation of the treatment and to verify its performance.

This paper presents a review of the different types of public buildings included in the noise insulation program and the noise control treatments utilised. An analysis of the noise reduction gained so far in the program (based on pre- and post-construction measurements). These results are compared to the noise reduction achieved during the residential part of the Adelaide Airport Noise Insulation Program is presented.

Introduction

The Department of Transport and Regional Services is overseeing a $63 million federally funded sound insulation program for residential and public buildings surrounding the Adelaide Airport. VIPAC was engaged by the Project Manager (Clifton Coney Group) as the acoustic consultant to design the treatments for the buildings, to oversee the installation of the treatment and verify the performance.

The project involves implementation of noise insulation treatments to about 600 residential dwellings within the 30 and 35 Australian Noise Exposure Concept (ANEC) noise contours as well as 5 selected public buildings within the 25 ANEC noise contours. It is based on aircraft noise level contour data provided by the Federal Airports Corporation and amelioration treatment guidelines developed from the Sydney Airport Noise Insulation Program (SANIP).

Building Types

The public buildings eligible for noise insulation treatment are built between 1884 and 1990 and therefore the building types vary considerably (Table 1).

Building Models and Achievable Noise Reduction

To predict the noise reduction and the internal noise level in the buildings (before and after treatment) models representing each of the buildings were developed.

For Flora McDonald, St George College and the Orthodox Coptic Church, each of them comprising a number of separate buildings, separate models representing each of the different buildings were developed. The evaluation of these models is current work in progress and is not discussed in this paper.

The models developed to represent St James Anglican Church and Mile End Church of Christ, the treatment of which has been completed and verified with pre-and post-treatment aircraft noise measurements are discussed below.

	Walls construction	Windows	Roof	Ceiling
St James Anglican Church (1884)	Stone masonry	Fixed with metal frame, lower part awning	Sheet metal pitched roof	N/A
Mile End Church of Christ (1926)	Solid double brick	Double hung with timber frame, lower part awning	Sheet metal pitched roof	Timber
Flora McDonald Lodge (c.1900 – 1990)	Brick veneer and stone masonry	Double hung, timber frame and sliding, aluminium frame	Sheet metal, both pitched and flat	Various
St George College (1983)	Solid brick and brick veneer	Awning & sliding, timber or steel frame	Sheet metal, both pitched and flat	Various
Orthodox Coptic Church (1956)	Brick veneer and lightweight (Sunday school)	Awning, timber frame and sliding, aluminium frame	Sheet metal, both pitched and flat	N/A

Table 1: Summary of building elements

Building Elements

St James Anglican Church:

The elements of the building envelope with construction as shown in Table 1 were modeled:

- External walls – stone masonry.
- Roof – sheet metal above timber boards with no ceiling cavity.
- Windows – 3mm thick float glass in metal frame.
- Entry doors – solid core timber doors with no seals.

Gaps were modeled around the entry doors and the operable windows as well as on the walls and roof to represent the subfloor vents and opening for the bell rope and roof gaps respectively.

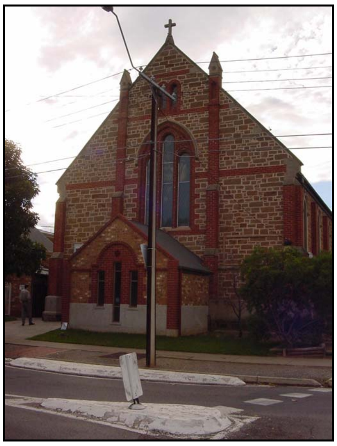

Fig.1: St. James Anglican Church

Mile End Church of Christ:

Building envelope elements with construction as shown in Table 1 were modeled:

- External walls – solid double brick.
- Roof – sheet metal above timber boarded ceiling.
- Windows – 3mm thick float glass in timber frame.
- Entry doors – hollow core plywood doors with no seals.

Gaps were modeled around the entry doors and the operable windows as well as on the walls and roof to represent the subfloor vents and the roof vents respectively.

Fig.1: Mile End Church of Christ

External Design Level (EDL)

AS 2021-2000 provides a method for predicting the sound pressure level (in dBA) at a building site resulting from aircraft landings and take offs based on the distances in meters from the runway centreline and both runway ends.

Based on coordinate information for each of the public buildings, as provided by the Department of the Environment and Heritage, the L_{Amax} for BOEING 737-300 (the aircraft considered as predominant for the Adelaide Airport) was calculated using AS 2021-2000. Measurements of the noise resulting from flyovers of different types of aircraft were taken at each of the buildings. The calculated EDL's and measurement results are presented in Table 2 as follows:

	Calculated EDL, dBA	Measured noise level, dBA
St James Anglican Church	86	87*
Mile End Church of Christ	85	85*

* *Averaged over the pre- and post-construction measurements*

Table 2: Calculated EDL's and measured external flyover noise levels

Criteria

AS 2021-2000 "Acoustics – Aircraft Noise Intrusion – Building Siting and Construction" sets a recommended indoor design sound level of 50dBA for determination of aircraft noise reduction for public buildings – churches and religious activities.

Noise Reduction and Internal Noise Level

To investigate the options for optimization of the noise insulation treatment and therefore for cost effectiveness, two treatment options was considered:

Optimal treatment:

- Sealing the gaps between the roof and the external walls.
- Either new secondary 6mm thick laminated glass windows offset from the existing windows by 150mm air gap or 10mm thick laminated glass offset from the existing window by 100mm air gap.
- Overlaying the ceiling with 85mm, 20kg/m^3 fibreglass batts and 4kg/m^2 flexible vinyl loaded acoustic barrier (Wavebar).
- Sealing of the wall and subfloor vents.
- Treatment of skylights – installation of secondary glazing and lining of the skylight shaft.
- Replacement of the external door with solid core timber door fitted with seals.

Non-optimal treatment:
The following elements were not acoustically treated:
- Gaps in the roof structure.
- Wall and subfloor vents.
- Replacement of the existing windows glazing with 10mm laminated glass instead of upgrading to double-glazing.

The findings of the analysis of the noise reduction achieved in the different types of residential buildings during the previous stage of the project showed:
- If a building is treated optimally (as detailed above), AS 2021-2000 criteria could be achieved in the areas with solid external walls (solid or double brick or brick veneer) and may not be achieved in rooms with lightweight external walls.
- An average noise reduction improvement higher than 10dBA throughout a building could be achieved by applying optimal treatment.
- Even an average noise reduction of about 10dBA throughout a residence could be achieved if a house is non-optimally treated, the AS 2021-2000 criteria could not be met.

Based on the above findings, the optimal treatment was applied to the buildings. However, given the type of the buildings and their heritage values, the following modifications in the treatment were made:
- Roofs - The roof structures of both churches were of significant concern. The absence of a ceiling void in St James and an old timber board ceiling with gaps in Mile End Church of Christ would reduce the effectiveness of the standard ceiling treatment. Therefore, the thickness of the fibrous insulation applied and the surface mass of the loaded vinyl noise barrier were doubled compared to the residential program to compensate.
- Windows – the original stained glass windows were retained and secondary windows as specified were installed.

Assessment of the Noise Reduction Gained

Measurement Procedure

To assess the effect of the noise insulation treatments, noise measurements were carried out in each of the public buildings before any acoustic treatment was applied and then, after the work on the building was completed. The maximum A-weighted sound pressure levels were measured simultaneously outside and inside the buildings. A Larson Davis LD2900 dual channel analyser was used in the measurements. The microphone reading the external noise levels was positioned at approximately 5m away from the facade. The internal sound pressure levels were measured approximately in the middle of the naves during five flyovers of representative aircraft (BOEING 737, 747, 767, A320 and A340).

Results

Pre- and post-construction measurements were carried out in both churches with the results of the treatment summarised below:
- The measured improvement in noise reduction was 18dBA and 21dBA for St James Anglican Church and Mile End Church of Christ respectively. We consider the higher noise reduction achieved in the Mile End Church of Christ to be a result of the additional noise reduction provided by the ceiling and the ceiling void.
- The recommended criterion of 50dBA was achieved in both of the churches.

Table 3 shows a comparison between the predicted sound pressure levels in each of the churches with the optimal treatment applied to the models and measured during aircraft flyovers after the optimal treatment was applied to the buildings.

	Model (predicted)		Building (measured)	
	SPL, dBA	Overall Reduction, dBA	SPL, dBA	Overall Reduction, dBA
St James Anglican Church	50	36	46	39*
Mile End Church of Christ	48	39	44	41*

* *Average based on the post-construction measurements only*

Table 3: Predicted and measured internal flyover noise levels

Conclusions

An analysis of the predicted and measured noise reduction among the different types of residencies during the residential part of the programs and the results achieved after completion of the works on the two churches revealed:
- The improvement in noise reduction gained as a result of the treatment of the churches is significantly higher than the highest average noise reduction improvement during the residential part of the program (18dBA and 22dBA compared to average of 11dBA measured among the Medium density and Conventional types residencies). We consider this as a result of the following factors:
  (a) Most of the buildings included in the residential part of the program had already been treated by the owners – mainly having ceilings overlaid with insulation (average noise level measured during pre-construction measurements of 62dBA in the

living rooms and 59dBA in the bedrooms compared to 69dBA and 65dBA measured in the churches).

(b) Significantly reduced noise transmission through the churches' façades due to the greater surface mass of the walls.

(c) Doubling of the thickness of the fibrous insulation and the surface mass of the loaded vinyl noise barrier applied to the churches' roof/ceiling structures.

	Pre-treatment		Post-treatment		Improvement
	External SPL dBA	Internal SPL dBA	External SPL dBA	Internal SPL dBA	
St James Anglican Church	90	69	85	46	18
Mile End Church of Christ	85	65	86	44	22

Table 4: Measured external and internal flyover noise levels prior and after treatment

- The analysis of the predicted and measured internal sound pressure levels confirmed that shielding and directivity factors should be accounted for during development of the models.

References

[1] AS 2021-2000 "Acoustics – Aircraft Noise Intrusion – Building Siting and Construction".

[2] VIPAC Document No 504397-TRP-11882-00 "Review of treatment menu", November 2000.

[3] Dimitrov, I., N.C. Mackenzie, "Adelaide Airport Noise Insulation Program", AAS Conference, Adelaide, November 2002