SOUND PROOFING OF A FORGE

Steven Cooper,
Steven Cooper Acoustics Pty Ltd
28A Woolwich Road, Hunters Hill NSW 2110
Member Firm of AAAC

ABSTRACT: A major forging company in Sydney was required by the NSW EPA to achieve a substantial noise reduction or be closed down. This paper sets out the acoustic solution developed for the company using a light weight multiple layered construction that achieved the stringent noise limits imposed by the NSW EPA. This noise control solution has been tested and proven to be most effective in achieving an outstanding environmental goal that has also resulted in a significant improvement in the occupational environment for air, noise, light and heat of employees working in the forge.

A plant operated by TRW Limited and located in Marrickville produces motor vehicle parts by forging and pressing metal that generates significant noise. The site is located adjacent to railway lines running south of Sydney that carry both passenger and freight traffic with the residential area of Tempe on the opposite side of the railway line and in some cases elevated on an escarpment that overlooks the forging plant. TRW have occupied the site since the turn of the century and operate their facility on a 24 hour basis with forging and pressing operations extending to 11pm at night. In late 1994 as a result of the change in the roof of one of the forges to permit a greater degree of natural light into the working space, residential receivers in proximity to the plant detected an increase in noise resulting in an investigation by the NSW EPA. Testing revealed the operation of the plant to exceed emission limits established in the mid 1970s and continued into the 1980s, resulting in the EPA issuing a requirement to significantly reduce noise emission from the premises some 20 dB(A) below the previous criteria, resulting in the need to reduce noise emission from the plant by some 37 dB(A).

Investigations were carried out in 1995 as to the feasibility of achieving the acoustic design criteria nominated by the NSW EPA, that in effect required the building envelope over the operating forge to achieve a noise reduction of 57 dB(A) instead of the nominal 17 dB(A) achieved by the asbestos clad building (with numerous holes) that had been in existence for many years. The brief for the feasibility study was to consider appropriate noise control solutions that could be implemented to the existing premises whilst maintaining production and guaranteeing compliance with EPA noise requirements. The main forging building now has a plan area of 3,000m^2 and could not support a concrete slab or similar to provide the required attenuation. Failure to comply with the design brief was likely to result in closure of the business in NSW, transfer of production facilities to off-shore or, subject to invitation of other State Governments to transfer the facilities to other States where a suitable site would be provided so as to not have a noise or other pollution problem.

As originally there were maximum levels generated in the building in the order of 110 - 115 dB(A) at 7 metres as a result of press operations and metal to metal impacts, together with a large reverberant energy component in the building, the design concept required the addition of absorption and transmission loss performance to guarantee compliance with the EPA criteria. Our previous design works in relation to aircraft noise insulation for Petersham and Enmore TAFE Colleges had utilised a multiplied layered system of Ortech Easiboard to achieve a high transmission loss performance in the low frequency bands from a light weight construction.

An extension of this principle was considered on a theoretical basis to achieve the required spectrum which necessitated a noise reduction performance in the order of 34 dB at 63 Hz with a proposed design solution incorporating three layers of the Easiboard panel in various combinations for the roof and wall upgrade of the building.

An engineering review by Acoustical Consultants in America on behalf of the parent company confirmed the theoretical conclusions of our study. However, an engineering review by an Australian organisation cast some doubt as to the effectiveness of the design concept (as there was no proven result for the proposed solution) whilst some EPA Engineers had reservations about the proposed solution meeting the design criteria.

Having to guarantee the performance of the complete system and placing our professional indemnity policy on the line, the preliminary design concepts were studied further. The ENM computer program with additional site measurements conducted at ground level and elevated areas of the forge confirmed the preliminary findings that, on the proviso the proposed constructions met our design specification, the EPA criterion would be satisfied. Accordingly having been through various engineering reviews and cost evaluations the company sought to proceed with the project subject to acoustic testing of the design solution. This was carried out in the RMIT acoustic test laboratories in Melbourne for a number of configurations. The testing in some cases reached the limits of the laboratory's capabilities in determining a transmission loss performance. Figure 1 sets out the design

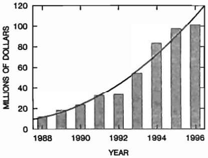

Figure 1. Forge Roof Construction

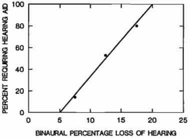

Figure 2. Forge Wall Construction

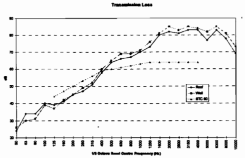

Figure 3. Transmission Loss Results

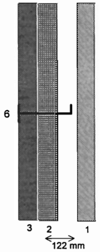

Figure 4. STC46 Dry Wall Construction

1 - 50mm thick Ortech Easiboard
2 - Ortech Acoustiboard with perf. F.C. facing
3 - 75mm thick Fibreglass
4 - 75mm perforated foil faced 8-12kg/m3 fibreglass on wire mesh
5 - 0.47 BMT Colorbond Custom Orb on 50mm thick blanket of 8-12kg/m3 fibreglass
6 - 175mm Ortech Duplex Beam
7 - Purlin Beam

philosophy for the roof/ceiling. Figure 2 shows the wall configuration which is marginally different to the roof/ceiling construction, so as to provide an attenuated passage for natural air flow and achieves slightly different transmission loss results but of similar magnitude (Figure 3).

A consequence of the testing allowed us to also ascertain the small cavity portion of the roof system to reveal a dry wall construction achieving a performance of STC46 (Figure 4).

The complexities of implementing such a noise control program whilst maintaining the operation of the forge required meticulous planning and staging of the project. A supporting structure was constructed over the existing structure, as Council required during the course of the construction that there was to be no increase in noise from the premises during normal operations. Accordingly the construction phase necessitated installing the internal ceiling components such that when roof panels were removed to provide the double layer system there would be no increase in noise emission. The building engineering design to accommodate the SCA acoustic solution was developed by Maunsell Consulting Engineers under the direction of specialist building advice from Montague Consultants, with the building works being supervised by Austin Australia.

Compliance testing carried out during the progress of construction confirmed the effectiveness of the design solution and gave a perfect example to the classic acoustical formulas for openings in a wall of different transmission performance. The closing of a large sliding door to be provided for maintenance purposes, that in itself had a sound transmission class in excess of 60, could be seen to have marginal reduction in noise until the opening was reduced to a small percentage and then the noise breakout dramatically disappeared.

The outcome of the control measures cannot be actually measured at the residential area as the operation of the forge is completely inaudible in the residential area some 150 metres from the factory. In effect when one is standing on the roadway 10 metres from the building one is able to feel vibration through the ground but unable to hear noise from inside the forge.

Measurements conducted inside the work area have revealed from the use of an acoustic pattern Easiboard as the ceiling of the premises a significant reduction in the reverberation component has been achieved. This resulted in a lowering of the maximum sound levels in the building by approximately 5 dB(A), with a reduction in the reverberant component approaching 7 dB(A).

The changes implemented to the building as a result of the noise control measures required by the EPA necessitate the building to be closed at all times, except for access tunnels that are acoustically treated to permit staff and fork lift trucks to enter the forge. The building itself has had to be mechanically ventilated and in addition to reducing by a significant margin the occupational noise levels inside the building, the project has provided a significant enhancement in light quality in the forge resulting in a vastly improved overall working environment for employees for a forging operation that is now in environmental terms permitted to operate 24 hours a day, 7 days a week.

The overall cost of the project approached $3.2 million and the innovative solutions used in addressing the environmental problems unique to the premises have resulted in the project being awarded by the Institution of Engineers (Sydney Division) an Engineering Excellence Award in 1997 for the category of Innovation and a Highly Commended Award for the category of Environment.