Rhino Doors

High Acoustic Attenuation Tunnel Vent Fan Room Doors

Region: UK Sector: Rail

CASE STUDY - 05

Challenge

When one of the largest Crossrail mainline stations needed a company to carry out the design, test, manufacture and installation of bespoke, multi-performance hinged steel doors for Tunnel Ventilation Fan (TVF) rooms, they turned to Rhino.

Large axial fans (circa 3m) are typically used to ventilate sub-surface sections in mainline, underground stations and mass transit rail (MTR) schemes. These fans produce 'jet engine' equivalent sound pressure levels that create potential health and safety and environmental noise risks. High levels of sound reduction are particularly important when fan rooms are located on external building elevations.

The plant access doors for the vent fan rooms were required to be manually operated, double leaf hinged constructions, measuring up to 5m wide by 4m high. The doors would be installed on external walls and would open outwards.

The performance specification called for E120 (2 hour) fire integrity, 1.62kPa static pressure and level 3 physical attack resistance combined with sound attenuation in excess of Rw 50dB. In addition, due to the close proximity of residential dwellings on one of the elevations, an average of 38dB sound pressure attenuation was specified across the low frequency 63 – 250Hz, 1/3rd octave band range. This ensured that the doors met the boundary noise levels laid down by the Environmental Protection Act.

Achieving this magnitude of low frequency sound reduction was the biggest challenge Rhino's design team faced on this project.

To achieve high sound attenuation at low frequencies, where sound waves have very long pitches, is typically achieved through the use of thicker, high mass leaf constructions which are combined with absorbent cavities and dampening layers. And, in order to eliminate high frequency losses around the edges of the leaves, it's vital that the leaves are tightly clamped against peripheral compression seals on all four edges.

Achieving this on oversize door constructions is exceptionally difficult.

Solution

Rhino embarked upon a detailed development and test programme to meet the sound spectrum specified and achieve a solution.

This development and test programme was centred on a series of small panel and large-scale door tests carried out to European Test Standard BS EN ISO10140-3 at the University of Salford Acoustic Laboratory. These tests were supplemented with computer modelling of the resonant frequencies produced by different structural steel section thicknesses.

Over an eight-week period Rhino tested 16 personnel door size samples to arrive at a combination of composite panels which met the specified attenuation spectrum. This compliant, small-scale design was replicated in a complete door construction which was then tested in the largest test aperture available at the University of Salford.

In addition to this testing, all of the requisite structural and static pressure design calculations were carried out in-house by Rhino's design team. The fire resistance performance was assessed on a project-specific basis by WarringtonFire. On completion of the acoustic tests, the large-scale test door (measuring 3.8m wide by 2.6m high) was subjected to a physical attack test.

Results

Following the completion of the extensive development and testing programme, the designs were deemed compliant with all of the requirements laid down by the performance specification.

When rated to BS EN ISO717-1, the large-scale acoustic test door achieved Rw 53dB and all the specified low to mid frequency sound pressure level reductions were exceeded. The attenuation registered at the critical 63Hz frequency was over twice the specified level.

The doors were subsequently manufactured to the approved designs and were duly installed on site according to the agreed programme. In total, Rhino has now supplied 15 oversized TVF doors across three Crossrail sites.