Air Leakage Characteristics of Smoke Control Doors

Parts of escape routes in buildings such as stair shafts and corridor enclosures that are constructed as 'safe paths' are intended to protect occupants from the hazards of fire and smoke originating elsewhere in the building. These 'safe paths' commonly rely on construction elements and particularly doors to protect against the entry of smoke. Smoke containment during a fire is of concern, because inhalation of smoke and toxic gases has historically been attributed as the major cause of fatalities in structure fires.

Current New Zealand Requirements

The safe path requirements for protection from smoke, as specified in the New Zealand Building Code (NZBC) Fire Safety Clause C2[1], is to "safeguard people from injury or illness from a fire while escaping". Smoke separations are required to avoid smoke spread by forming "an imperforate barrier to the spread of smoke".[2] That is, the measure of smoke resistance required is absolute, which is not realistically achievable.

By definition, a smoke control door is required to have leaves that are "close-fitting" to the frame and are "impermeable to the passage of smoke" and fitted with smoke seals.[2] These are qualitative requirements.

In addition, smoke control door installation requirements cover human interaction considerations, such as hinging, self-closing mechanisms, locking devices, direction of opening, opening dimensions, vision panels, hold-open devices, and locations. For instance, the maximum forces required to unlatch, move and open a smoke control doors are specified.

Doorsets require clear markings to show their fire resistance rating (FRR), including 'Sm' to indicate smoke stopping capability (P. 6.19.6)[2]. The FRR is a quantitative indication of the ability of a component to maintain specified levels of structural stability, integrity and insulation when exposed to a standard fire test. Whereas the smoke control capability (indicated by 'Sm') is usually achieved by fitting smoke seals at the head and all vertical edges in the gaps between the door leaf or leaves and the frame, and between leaves in multi-leaf doorsets (P. 6.19.2)[2]. However there are no numerical criteria associated with an acceptable level of smoke control capability. Also no testing is currently required to assess the ability of a doorset to stop smoke.

Testing the Effectiveness

The performance of a smoke control door depends on a combination of conditions and the type of door including:

- Temperatures the door is exposed to,
- Pressure differences across the door, and
- Combination of the leaf, frame, seals and hardware of the door assembly.

Therefore the effectiveness of each specific door and seal combination must be tested for different temperature and pressure conditions. The general requirement for a generic smoke seal to be fitted does not provide a known level of smoke stopping capability.

Several standard tests for determining the air leakage of doors are available. For example, ISO 5925, UBC 7-2 Part II and DIN 18095/2. There is also a joint Australian and New Zealand standard for testing the air leakage of doors (AS/NZS 1530.7:1998). However this particular standard does not include levels of maximum acceptable levels

of air leakage through the doors. An acceptance criteria must also be specified where this standard is referenced. As a result of research conducted in Australia, Warrington Fire Research recommended a maximum air leakage rate of 15 m^3/h per leaf at a cross-door pressure difference of 25 Pa when tested under the conditions of AS/NZS 1530.7.[3]

Recent BRANZ research considered air leakage through smoke control doors at ambient, medium and high temperatures.[4] The results of testing showed that the characteristic air leakage changed significantly between the considered temperature ranges.

The conclusions of this research[4] included recommendations for a standard test method for determining air leakage rates, at ambient and medium temperatures such as AS/NZS 1530.7 "Methods for Fire Tests on Building Materials, Components and Structures - Smoke Control Door and Shutter Assemblies - Ambient and Medium Temperature Smoke Leakage Test Procedure" be specified in NZBC Fire Safety Compliance Documents C/AS1[2]. In addition, for smoke control doors to be effective clear signage and other installation requirements are required, therefore criteria such as those specified in the latest draft for public comment of AS 1905.3 "Components for the protection of openings in fire resistant walls – Part 3: Smoke door assemblies" (DR 06346)[5] were recommended. When AS/NZS 1530.7 is specified, it is recommended that the maximum allowable air leakage rates suggested in these documents be listed as required performance levels. That is, the maximum measured air leakage rate, at ambient or medium temperature conditions, corrected to Standard Reference Conditions at a cross-door pressure difference of 25 Pa must not exceed 25 and 40 m^3/h for single and two leaf doorsets respectively. These suggested values for maximum air leakage performance criteria are in agreement with ranges of values currently suggested elsewhere[5,6]. It was also recommended that New Zealand regulators and industry remain active on relevant joint standard committees and workgroups with Standards Australia to ensure the appropriateness of technical content and foresight of possible impacts of up-coming changes.

Overseas Requirements

Similar to the NZ regulations, Australian regulations require protection from smoke, but also do not call up standards that specify test methods for measuring air leakage of smoke control doors nor are acceptable levels of smoke stopping capability defined.

However regulations of other countries do specify testing and performance criteria for smoke doors, such as

- USA: maximum air leakage of 54 m^3/h per square metre of opening [7] at specified cross-door pressures and temperatures.[8,9,10]
- England, Scotland and Wales: require a maximum air leakage rate of 3 m^3/h per metre of gap, when tested at a specified cross-door pressure.[11]
- Germany: maximum air leakage of 20 m^3/h for single-leaf and 30 m^3/h for double-leaf doors at specified temperatures and cross-door pressures.[12]

Future Direction

Good smoke management, no matter which strategy is employed (e.g. exhaust, ventilation, pressurisation or containment), depends on a combination of known and dependable elements – of which smoke control doors are one element. Smoke control doors are of no value unless appropriate smoke stopping characteristics for the situation are selected, an ongoing maintenance schedule is practiced and the operation of the door is unhindered. Inclusion of appropriate quantitative performance criteria and

standard test method for smoke control doors in the current NZBC Fire Safety Compliance Documents C/AS1 requirements would improve the confidence associated with passive smoke containment systems.

References

1 New Zealand Building Code, The New Zealand Building Code Handbook. 2004. Victoria University Book Centre, Wellington.

2 Acceptable Solution (C/AS1), Compliance Documents for New Zealand Building Code Fire Safety Clauses C1, C2, C3, C4. 2005. Victoria University Book Centre, Wellington.

3 Technical Specification for Air Leakage Testing in accordance with AS 1530.7:1998. 2003. WFRA FSE 04.1. Warrington Fire Research Australia.

4 Edwards APR and Wade CA. 2006. 'Leakage of Smoke Control Door Assemblies'. BRANZ Ltd. Study Report SR 151, Judgeford, New Zealand.

5 DR 06346, Draft for Public Comment: Components for the protection of openings in fire-resistant walls, Part 3: Smoke door assemblies (AS 1905.3). 2006. Homebush, NSW, Standards Australia.

6 DR 06279 Draft for Public Comment: Methods for fire tests on building materials, components and structures – Part 7: Smoke control door and shutter assemblies – ambient and medium temperature smoke leakage test procedure (AS/NZS 1530.7:1998). 2006. Homebush, NSW, Standards Australia.

7 NFPA 105, Standard for the Installation of Smoke Door Assemblies. 1999. National Fire Prevention Association, Quincy, MA.

8 Uniform Building Code, Volume 3: Materials, Testing and Installation Standards. 1997. UBC 7-2, Fire Tests of Door Assemblies, Part II: Test Standard for Smoke- and Draft-control Assemblies of the International Conference of Building Officials. International Conference of Building Officials, Whitter, CA.

9 International Building Code. 2003. International Code Council, Inc., Country Club Hills, IL.

10 NFPA 5000, Building Construction and Safety Code. 2003. National Fire Prevention Association, Quincy, MA.

11 Knight's Building Regulations 2000 (with Approved Documents) Volume 3, The Building Regulations 2000, Fire Safety, Approved Document B. 2004. Office of the Deputy Prime Minister, London.

12 DIN 18095/2, Smoke Control Doors - Part 2: Type Testing for Durability and Leakage. 1991. Beuth Verlag GmbH, Berlin.