Design Approach for Performance-Based Building Codes

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Outline

- Objective
- Review Design Approaches
- Overview Australian performance based building codes
- Overview of ICC Performance Code
- Compare and contrast prescriptive and performance based codes
- Conclusions
- Questions for PDH credit
Objective

The attendee shall have an understanding of the steps involved to achieve a performance solution and be able to identify the benefits and drawbacks to performance-based codes.
Prescriptive vs. Performance Approach

Prescriptive Approach – Strict, usually quantitative, requirements

Performance Approach – Qualitative requirements to achieve a set goal

A performance approach does not preclude the use of prescriptive specifications.
Australia - Overview

Six States
- New South Wales (NSW), Queensland (QLD), South Australia (SA)
  Tasmania (TAC), Victoria (VIC), Western Australia (WA)

Two Territories
- Australian Capital Territory (ACT) and Northern Territory (NT)
Australia - Overview

Federal Government
• Implementation and enforcement of building regulations for federal buildings

State or Territory Government
• Implementation and enforcement of building regulations
• Emergency services

Local Government
• Enforcement of building regulations
National Construction Code

- Produced and maintained by the Australian Building Codes Board on behalf of the Australian Government and each State and Territory Government
- Adopted by regulation in all States and Territories
- Document amended for each State and Territory in appendix
National Construction Code Format

VOLUME ONE
• Building Code of Australia
• All Class 2 to 9 buildings (excludes some residential and non-habitable building or structures)

VOLUME TWO
• Residential Code of Australia

VOLUME THREE
• Plumbing Code of Australia
• Applies to all buildings
The NCC is drafted in a performance format allowing a choice of *Deemed-to-Satisfy Solutions* or flexibility to develop *Performance Solutions* based on existing or new innovative building, plumbing and drainage products, systems and designs.

When complying with the *Deemed-to-Satisfy Provisions*, or when developing *Performance Solutions* in order to comply with the NCC, considerations may need to be given to whether the solution impacts on compliance with other Parts of the NCC.
The goal of the NCC is to enable the achievement of nationally consistent, minimum necessary standards of relevant safety (including structural safety and safety from fire), health, amenity and sustainability objectives efficiently.

This goal is applied so that-
(a) There is a rigorously tested rationale for the regulation; and
(b) The regulation is effective and proportional to the issues being addressed such that the regulation will generate benefits to society greater than the costs (that is, net benefits); and
(c) There is no regulatory or non-regulatory alternative (whether under the responsibility of the Board of not) that would generate higher net benefits; and
(d) The competitive effects of the regulation have been considered and the regulation is no more restrictive than necessary in the public interest.
Decisions made under the BCA should be fully documented and copies of all relevant documentation should be retained.

Examples of the kind of documentation which should be prepared and retained include:

(a) Details of the *Performance Solution* or the *Deemed-to-Satisfy Solution* including all relevant plans and other supporting documentation.

(b) In cases where a *Performance Solution* has been proposed-
   i. Details of the relevant *Performance Requirements*; and
   ii. The *Assessment Method* or methods used to establish compliance with the relevant *Performance Requirements*; and
   iii. Details of any *Expert Judgement* relied upon including the extend to which the judgement was relied upon and the qualifications and experience of the expert; and
   iv. Details of any tests or calculations used to determine compliance with the relevant *Performance Requirements*; and
   v. Details of any Standards or other information which were relied upon.
A0.1 Compliance with the NCC
Compliance with the NCC is achieved by satisfying the *Performance Requirements*.

A0.2 Meeting the Performance Requirements
The *Performance Requirements* can only be satisfied by a-

(a) *Performance Solution*; or
(b) *Deemed-to Satisfy Solution*; or
(c) Combination of (a) and (b).

**Note:**
1. The term *Performance Solution* was formerly known as *Alternative Solution*.
2. The terms *Performance Solution* and *Deemed-to-Satisfy Solution* were formerly used under the term *Building Solution*.
A0.3 Performance Solutions

(a) A Performance Solution must-
  (i) Comply with the Performance Requirements; or
  (ii) Be at least equivalent to the Deemed-to-Satisfy Provisions,
       and be assessed according to one or more of the Assessment Methods.

(b) A Performance Solution will only comply with the NCC when the Assessment Methods used satisfactorily demonstrate compliance with the Performance Requirements.
A0.5 Assessment Methods

The following Assessment Methods, or any combination of them, can be used to determine that a Performance Solution or a Deemed-to-Satisfy Solution complies with the Performance Requirements, as appropriate:

(a) Evidence to support the use of a material or product, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision as described in A2.2.

(b) Verification Methods such as:
   (a) The Verification Methods in the NCC; or
   (b) Such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.

(c) Expert Judgement.

(d) Comparison with the Deemed-to-Satisfy Provisions.
A0.7 Relevant Performance Requirements

In order to comply with the provisions of A1.5 (to comply with Section A and the NCC Performance requirements) the following method must be used to determine the Performance Requirement or Performance Requirements relevant to the Performance Solution:

(a) Where a Performance Requirement is satisfied entirely by a Performance Solution:

i. Identity the relevant Performance Requirement from the Section or Part to which the Performance Solution applies.

ii. Identify Performance Requirements from other Sections or Parts that are relevant to any aspects of the Performance Solution proposed or that are affected by the application of the Performance Solution.
(b) Where a Performance Requirement is satisfied by a Performance Solution in combination with a Deemed-to-Satisfy Solution:

i. Identify the relevant Deemed-to-Satisfy Provisions of each Section or Part that is to be the subject of Performance Solution.

ii. Identify the Performance Requirements from the same Sections or Parts that are relevant to the identified Deemed-to-Satisfy Provisions.

iii. Identify Performance Requirements from other Section or Parts that are relevant to any aspects of the Performance Solution proposed or that are affected by the application of the Deemed-to-Satisfy Provisions that are the subject of the Performance Solution.
BCA Acceptance of Design and Construction

A2.1 Suitability of materials

Every part of a building must be constructed in an appropriate manner to achieve the requirements of the BCA, using materials and construction being fit for the purpose for which they are intended including the provision of access for maintenance.
A2.2 Evidence of suitability

(a) Subject to A2.3 and A2.4, evidence to support that the use of a material, form of construction or design meet a Performance Requirement or a Deemed-to-Satisfy Provision may be in the form or one of a combination of the following:

I. A report issued by a Registered Testing Authority, showing that the material or form of construction has been submitted to the tests listed in the report, and setting out the results of those test and any other relevant information that demonstrates it suitability for use in the building.

II. A current Certificate of Conformity or a current Certificate of Accreditation.

III. A certificate from a professional engineer or other appropriately qualified person which –
   A. Certifies that a material, design, or form of construction complies with the requirements of the BCA; and
   B. Sets out the basis on which it is given and the extent to which relevant specifications, rules, codes of practice or other publications have been relied upon.
BCA Acceptance of Design and Construction

IV. A current certificate issued by a product certification body that has been accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ)

V. * * * * *

VI. Any other form of documentary evidence that correctly describes the properties and performance of the material or form of construction and adequately demonstrates its suitability for use in the building.
(b) Evidence to support that a calculation method complies with an ABCB protocol may be in the form of one or a combination of the following:

I. A certificate from a professional engineer or other appropriately qualified person which –
   A. Certifies that the calculation method complies with a relevant ABCB protocol; and
   B. Sets out the basis on which it is given and the extent to which relevant specifications, rules, codes of practice and other publications have been relied upon.

II. Any other form of documentary evidence that correctly describes how the calculation method complies with a relevant ABCB protocol.

(c) Any copy of documentary evidence submitted, must be a complete copy of the original report or document.
BCA Example 1 – Automatic Sprinkler System

PERFORMANCE REQUIREMENT

EP1.4 An automatic fire suppression system must be installed to the degree necessary to control the development and spread of fire appropriate to—
(a) The size of the fire compartment; and
(b) The function or use of the building; and
(c) The fire hazard; and
(d) The height of the building.
BCA Example 1 – Automatic Sprinkler System

DEEMED-TO-SATISFY PROVISIONS

E1.5 Sprinklers

A sprinkler system must –
(a) Be installed in a building or part of a building when required by Table E1.5; and
(b) Comply with Specification E1.5
Example 1 – Automatic Sprinkler System

DEEMED-TO-SATISFY PROVISIONS

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>When sprinklers are required</th>
</tr>
</thead>
<tbody>
<tr>
<td>All classes—</td>
<td>Throughout the whole building if any part of the building has an effective height of more than 25 m.</td>
</tr>
<tr>
<td>(a) including an open-deck carpark within a multi-classified building; but</td>
<td></td>
</tr>
<tr>
<td>(b) excluding—</td>
<td></td>
</tr>
<tr>
<td>(i) an open-deck carpark being a separate building; and</td>
<td></td>
</tr>
<tr>
<td>(ii) a Class 8 electricity network substation, with a floor area not more than 200 m², located within a multi-classified building.</td>
<td></td>
</tr>
<tr>
<td>Class 3 building used as a residential aged care building</td>
<td>Throughout the building and in any fire compartment containing a Class 3 part used for residential aged care.</td>
</tr>
<tr>
<td>Class 6</td>
<td>In fire compartments where either of the following apply:</td>
</tr>
<tr>
<td></td>
<td>(a) A floor area of more than 3,500 m².</td>
</tr>
<tr>
<td></td>
<td>(b) A volume more than 21,000 m³.</td>
</tr>
<tr>
<td>Class 7a, other than open-deck carparks</td>
<td>In fire compartments where more than 40 vehicles are accommodated.</td>
</tr>
<tr>
<td>Class 9a health care building used as a residential aged care building</td>
<td>Throughout the building and in any fire compartment containing a Class 9a part used for residential aged care.</td>
</tr>
</tbody>
</table>
Example 1 – Automatic Sprinkler System

PERFORMANCE SOLUTION

- Hospital (Class 9a building) with data center room containing patient medical records
- Fire sprinklers required throughout the building
- Fire sprinklers undesirable due to contents

Proposed Performance Solution – Clean Agent System
BCA Example 1 – Automatic Sprinkler System

PERFORMANCE SOLUTION – CLEAN AGENT SYSTEM

• Review performance requirements
• Consider impacts on other parts of code
• Prepare documentation
  – Details of Performance Requirements
  – Assessment method
  – Expert judgement
  – Test and calculations
  – Details of standards or other information used
• Gain acceptance of Authority
BCA Example 2 – Exit Stairways

PERFORMANCE REQUIREMENT

**DP4** Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to-

(a) The travel distance; and
(b) The number, mobility and other characteristics of occupants; and
(c) The function or use of the building; and
(d) The height of the building; and
(e) Whether the exit is from above or below ground level.
**BCA Example 2 – Exit Stairways**

**DEEMED-TO-SATISFY PROVISIONS**

**D1.2 Number of exits required**

(b) **Class 2 to 8 buildings** – In addition to any horizontal exit, not less than 2 exits must be provided from the following:

(i) Each storey if the building has an effective height of more than 25 m.
Example 2 – Exit Stairways

PERFORMANCE SOLUTION

• 3-story office building (Class 5)
• Two stairways are proposed however only one is proposed as fire-isolated, meeting the definition of an exit. The other stairway is not fire-isolated as it located in an atrium and does meet the requirement as an exit stair.

Proposed Performance Solution – Smoke Management System
BCA Example 2 – Exit Stairways

PERFORMANCE SOLUTION

• Review performance requirements
• Consider impacts on other parts of code
• Prepare documentation
  – Details of Performance Requirements
  – Assessment method
  – Expert judgement
  – Test and calculations
  – Details of standards or other information used
• Gain acceptance of Authority
ICC Performance Code

- Not adopted in New York State
- Adopted in 14 states on local level only
- Adopted by state for local adoption – SC
  - Must be adopted by local ordinance before enforcement
- Statewide adoption with limitations – OK
- Statewide adoption - PA
101.1 Purpose. To provide appropriate, health, safety, welfare, and social and economic value, while promoting innovative, flexible and responsive solutions that optimize the expenditure and consumption of resources.

101.2 Intent.

101.2.1 Building. To provide an acceptable level of health, safety, and welfare and to limit damage to property from events that are expected to impact buildings and structures.
ICC Performance Code

Procedural Steps for New Buildings

1. Preparation of a concept report by a qualified principal design professional
2. Design preparation by a design team headed by a qualified principal design professional
3. Coordination and verification with other design professionals, owners and contractors where applicable
4. Submit plans and supporting documents to the code official
5. Plan review conducted by code official
6. Code official verifies that applicable prescriptive code provisions and performance based objectives are met
7. Code official approves plans and issues permit
8. Permit holder constructs in accordance with approved plans and documents
9. Code official ensure that qualified inspection services are provided and documented where required
10. Issue Certificate of Occupancy
ICC Performance Code

ICC Performance Code for Buildings and Facilities

Administrative Provisions

Design Performance Levels

Objectives

Functional Statement

Performance Requirements

Section 104 Acceptable Methods

General administrative procedure particular to a performance code Chapters 1 and 2

Provides guidance on design performance levels Chapter 3

Topic-specific intent statements Chapters 4 through 22

Not in Code

Prescriptive Codes

Solution

Authoritative Documents and Design Guides

Performance Criteria

Measurable-example design load, heat flux

Verification

Testing, modeling, etc.

Other Design Documents

Documentation

Solution
Example – Ch. 6 Fire Safety

601.1 Objective. To prevent unwanted ignition caused by building equipment and systems.

601.2 Functional statements.
601.2.1 Fuel-burning appliances and services. Fuel-burning appliances and services shall be installed in a manner that reduces their potential as a source of fire ignition.

601.3 Performance requirements.
601.3.1 Uncontrolled combustion and explosion. Fuel-burning appliances and services shall be installed so that the appliance or service will not cause uncontrolled combustion or explosion.
# Prescriptive vs. Performance-Based Codes

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
</table>
| • Familiarity  
• Simplicity  
• Ease of use | • Incomplete  
• Shallow  
• Overly Optimistic  
• Needs updating |
| **PRESCRIPTIVE-BASED CODES** |  |
| • Flexibility  
• Innovative  
• Potential cost savings  
• Transparency | • Limited  
• Potential for additional costs |
| **PERFORMANCE-BASED CODES** |  |
Concluding Remarks

- Understand the benefits and limitations of both code formats
- Have all stakeholders involved early and throughout the process
- Understand the goals or objective
- Provide sufficient and complete documentation
Sources


QUESTIONS AND/OR COMMENTS?
Questions for PDH Credit

1. In a performance-based design, compliance with prescriptive requirements is met by meeting the established PERFORMANCE REQUIREMENT.

2. What are some benefits to performance-based codes?
   - FLEXIBILITY, INNOVATIVE, POTENTIAL COST SAVINGS, TRANSPARENCY

3. What are some drawbacks of performance-based codes?
   - LIMITED, POTENTIAL FOR ADDITIONAL COSTS