Performance metrics for cold water pipework sizing in the National Construction Code

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Abstract

The Australian Building Codes Board (ABCB) is proposing to quantify the Performance Requirement for the sizing of pipework in cold water systems in the next iteration of the National Construction Code (NCC). This is intended to allow practitioners to determine the size of cold water pipework using any method that can suitably demonstrate the required level of performance is met. The metric allows the design of an individual system to be tailored to any combination of fixture types, number of fixtures, fixture flowrates and probability of fixture usage.

The prescriptive standard for the design of water supply systems in buildings in Australia is AS/NZS 3500.1, which is based on Hunter's method of using fixture units to calculate Probable Simultaneous Flow Rate. Hunter's method is premised on the calculation of water demand at the 99th percentile of likely demand during congested use, however the assumed values of flowrates and probability of use of fixtures are fixed.

In reality, different buildings will vary in their fixture flowrates and probabilities of use, and therefore systems are designed at flowrates that can be higher or lower than the 99th percentile of actual demand. The result is that supply water pipework in Australia is frequently oversized, resulting in sub-optimal cost and design outcomes.

The key metric proposed to be included in the NCC Performance Requirement is for pipework water velocity not to exceed 3m/s at the 99th percentile of likely non-zero flow during the hour of peak downstream usage. Pressure-based requirements equal to existing requirements are also specified. Specifying the level of performance that must be achieved by a pipework system, rather than specifying how it must be calculated, will enable designers to use more sophisticated methods of determining the appropriate size of pipework, allowing improved design outcomes in cold water systems in Australia.

Keywords

Plumbing water supply; building water pipe sizing; design flow rate; performance based design; regulation

1 Introduction

The National Construction Code (NCC) contains the minimum regulatory requirements for buildings, structures, plumbing and drainage systems in Australia.

The NCC is a performance-based code, where compliance is demonstrated by meeting the Performance Requirements. In NCC 2019, the Performance Requirement that determines the sizing of cold water pipework is qualitative in nature, making it difficult to demonstrate compliance with the requirement without referring to the prescriptive optional method of demonstrating compliance, known as a Deemed to Satisfy (DTS) method. This paper investigates how the Performance Requirement may be changed in NCC 2022 to be quantitative and objective, clarifying the level of performance that must be achieved for an alternative method to demonstrate compliance with the Performance Requirement.

There are a number of valid methods of sizing cold water pipework which aren't currently referenced in the NCC. By clarifying the level of performance that must be achieved by a cold water system, any method that can satisfactorily demonstrate that the required level of performance is met may be used to meet the Performance Requirement.

Alternative methods may already be used to demonstrate compliance with the existing qualitative Performance Requirement. However, subjective requirements act to discourage practitioners due to lack of clarity in the level of performance that must be demonstrated, and lack of confidence that a regulating authority will interpret the level of performance required to be at the same level as the judgement of the practitioner. A quantitative Performance Requirement is intended to allow for improved design outcomes in a cold water system by more easily allowing design methods that are more sophisticated and accurate than the DTS method.

2 The basis of current design requirements

The current Performance Requirement for the sizing of cold water piping, as included in NCC 2019, is shown in Figure 1.

BP1.2 Design, construction and installation

(1) A cold water service must ensure the following:

(a) Water is provided at *required* flow rates and pressures for the correct functioning of fixtures and appliances.

Figure 1: NCC 2019 Performance Requirement

The Performance Requirement is fundamentally qualitative and subjective, making it difficult to demonstrate that the requirement is met without referencing the DTS method of compliance. To determine the de-facto level of performance specified by the Performance Requirement, the DTS methodology must be considered.

The DTS method references AS/NZS 3500.1, which in turn specifies three primary parameters that relate to the sizing of cold water pipework:

(1) Maximum pipework design velocity of 3m/s at the Probable Simultaneous Flow Rate (PSFR)
(2) Minimum fixture design pressure of the greater of 50 kPa, or minimum required by the fixture to function
(3) Maximum fixture design pressure of 500kPa

In the case of (1), PSFR is calculated using the loading unit methodology, which was originally developed in the early 20^{th} century by Roy B. Hunter (Hunter, 1940). The loading unit methodology described by Hunter is premised on the calculation of PSFR at the 99^{th} percentile of likely demand during congested use. The loading unit methodology has provided an easy to use method of cold water pipework sizing, however the method also has limitations. The assumed values of flowrates and probability of use of fixtures are fixed when using the loading unit method, meaning designs cannot be tailored to the unique circumstances of different buildings.

Including the above minimum performance metrics within the Performance Requirement itself is considered in the following section.

3 Performance metrics for inclusion in the NCC Performance Requirement

In the public comment draft of NCC 2022 it is proposed to reference the three identified parameters directly within the Performance Requirement of the NCC. The Performance Requirement for cold water pipework sizing is tentatively proposed to be re-written, as shown Figure 2.

> A cold water service must ensure the following:
> (a) Pipework water velocity must not exceed 3m/s at the 99^{th} percentile of likely non-zero flow during the hour of peak downstream usage; and
> (b) The water pressure at any outlet must not be less than the greater of 50 kPa or the minimum pressure required by the fixture to function; and
> (c) The water pressure at any outlet must not exceed 500 kPa.

Figure 2: Draft NCC 2022 Performance Requirement

The key difference between the proposed Performance Requirement and the Deemed to Satisfy method is the explicit inclusion of the flow rate to be considered at the 99^{th} percentile of likely non-zero flow during the hour of peak downstream usage. In contrast, Hunters work considers the 99^{th} percentile of flow during congested use.

The new metric is intended to align with established contemporary methods of performance-based cold water system design, and is for instance similar to the underlying performance target of the IAPMO Water Demand Calculator (Buchberger, Omagomi, Wolfe, Hewitt, Cole, 2017).

Restating the Performance Requirement in this way is intended to add clarity on the use of methods of sizing cold water pipework other than the DTS loading unit method. The loading unit method has fixed assumptions in regards to expected usage patterns of plumbing fixtures. In reality, plumbing fixture usage may vary between building types. For instance the usage pattern in an apartment block may vary significantly from usage in an office building. This will cause the loading unit method to result in design flowrates to vary from the originally modelled 99th percentile of likely flow rate, potentially resulting in sub-optimal sizing of plumbing systems. Quantifying required system performance, rather than specifying a particular method, is intended to allow practitioners to more accurately size pipework in cold water systems.

4 Further work

This work is one step to allowing improved methods of designing cold water systems in Australia to show compliance with the NCC. Other areas the Australian Building Codes Board are interested in exploring further include:

- Consideration of unintended consequences.
- Direct reference in the NCC to methods of demonstrating compliance with the Performance Requirement.
- Collation of fixture usage data for different building types to aid practitioners in completing designs to meet the Performance Requirement.
- Quantification of other plumbing Performance Requirements in the NCC.

5 Conclusion

Including quantified metrics in the NCC Performance Requirement for cold water pipework sizing is intended to give practitioners and regulators confidence in assessing methodologies that are not referenced in the DTS of the NCC.

Specifying the level of performance that must be achieved by a pipework system, rather than specifying how it must be calculated, will allow designers to use more advanced methods of calculating the probable simultaneous flowrate in cold water systems, and to size pipework accordingly, allowing improved design outcomes in cold water systems in Australia.

6 References

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7 Presentation of Authors

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