Aspects of Facade Design

Assessing the Structural Adequacy and Performance of External Cladding and Facade Systems

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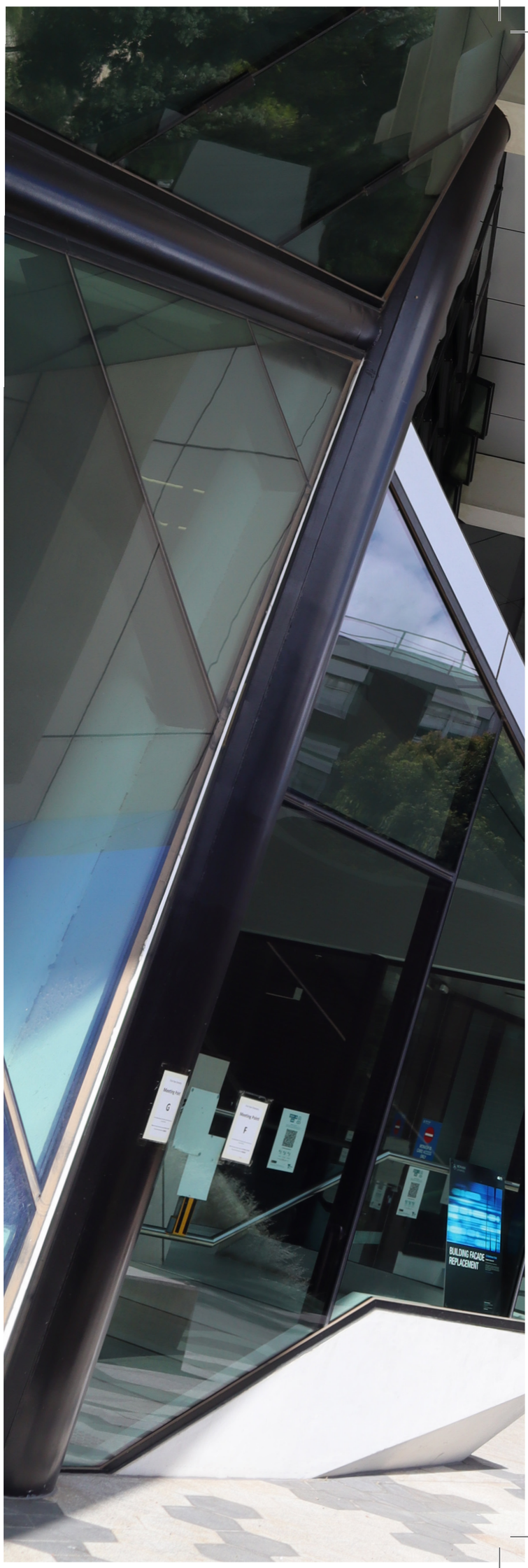
Introduction

In the architectural field, the building facade is one of the most important elements of a building. Although a facade design is only the front of a building, it also expresses the personality of the building and its users. But beyond just looks, the facade protects the building from natural elements such as wind, rain and extreme temperatures while providing a layer of insulation, soundproofing and other features.

Facade systems are made up of building envelope components that provide weather resistance, and thermal, acoustic, and fire resistance, as well as structural elements that provide lateral and vertical resistance to wind and other actions. The risk of deterioration and subsequent failure increases as facades are constantly exposed to climatic changes.

Given the rising complexity of modern building envelopes, it is essential to evaluate facade performance in terms of structural integrity and durability. Early consideration of these factors will help avoid expensive and potentially dangerous flaws during the building's service life.

To ensure safety, stability, and longevity, the design and construction of the entire facade system should meet Australian standards and be tested in accordance with them. Below we take a closer look at aspects of structural performance testing for external cladding and facade systems.



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Serviceability and ultimate strength performance

Engineers working on external facade systems will typically evaluate each system's serviceability and ultimate strength performance when determining the structural performance of the system. Limit state design (LSD) is a structural engineering design method where actions that are likely to take place over the course of a structure's design life are taken into account to make sure the structure remains fit for use with the necessary levels of reliability.[1]

Under the LSD methodology, a structure may reach a "limit state" as a result of loading or other imposed actions, at which point it no longer meets the design requirements for usability, structural integrity, durability, and other factors. Two principal criteria must be satisfied: ultimate limit state and serviceability limit state.

The phrase "ultimate limit state" (ULS) refers to the requirement that a structure must be capable of bearing the maximum load permitted while also including sufficient safety margins to guarantee the safety of the structure and/or occupants. This criterion aims to ensure that the probability of collapse or failure is at an acceptable level.

“Serviceability limit state” (SLS) describes a limit that concerns the appearance and serviceability of a structure. The design objective is to ensure the structure remains functional for its intended purpose subject to routine loading and deflections.

There will be predetermined SLS and ULS criteria for each construction project. For commercial projects, procedures and standards for building structural design are outlined in AS/NZS 1170 “Structural design actions”. This Standard defines the design values for use in structure design for wind, snow, ice, and earthquake actions, among other permanent and imposed actions. In terms of structural testing, AS/NZS 1170 defines the SLS and the ULS.

When it comes to residential projects, AS 4055:2021 “Wind loads for housing” specifies site wind speed classes for determining design wind speeds and wind loads for the design of housing and for the design, manufacturing and specifying of building products and systems used for housing.

Deflection criteria

When engineers working on facades evaluate the suitability of panels or systems, deflection criteria is another important consideration. The amount of movement or displacement that a structural member experiences as a result of an applied load is known as deflection. The magnitude of the applied load, the member's span, and the member's stiffness all affect how much deflection occurs.

Deflection criteria is a critical aspect of serviceability limit state design. Building regulations and standards provide the maximum allowable deflection that is acceptable with respect to the intended use of the building; the potential for building damage as a result of deflection; and other factors such as shrinkage, temperature changes and pre-stress conditions.

In order to prevent the cladding system from being subjected to unexpected loads, the primary building structure bears the weight for all cladding types while the support system allows relative movement. The cladding has to accept deflection of the supporting structure and allow for vertical and horizontal movement.

A facade system should be designed with deflection criteria in mind. The sizing and spacing of system components, such as the framing and how cladding panels are fixed to it, must be determined with reference to applied loads and deflection limitations.

If there is insufficient allowance for in-service movements between the facade and the primary structure, the building envelope will be subject to loads that it is not designed to carry. Leaks, cracks, connection failures, buckling and glass breakage can follow as a result.

AS 4040 structural testing

The AS 4040 “Methods of testing sheet roof and wall cladding” series specifies a series of test method options which can be applied to sheet roof and wall cladding of various forms and base materials. This series of standards addresses design wind pressure criteria for both AS 1170 and AS 4055 for commercial and housing buildings respectively, along with deflection limit criteria in accordance with AS 1562.1:2018 “Design and installation of metal roof and wall cladding – Metal”.

Manufacturers and suppliers of wall and roof cladding may want to create load span design tables for their products to assist facade designers, specifiers and engineers. Some systems and products on the market have generic wind pressure-based span tables that are frequently based on specific materials, like aluminum.[2] Without actual testing, the data in such tables would only be implied, and could be very inaccurate in practice.[3]

The AS 4040 series of tests must be taken into consideration in order to create comprehensive and accurate load-span design tables. Note that it is not mandatory to conduct all three tests.

AS 4040 test method options are as follows:

- AS 4040.1:1992 “Methods of Testing Sheet Roof and Wall Cladding – Resistance to Concentrated Loads”;
- AS 4040.2:1992 “Methods of Testing Sheet Roof and Wall Cladding – Resistance to Wind Pressures for Non-Cyclone Regions”; and
- AS 4040.3:1992 “Methods of Testing Sheet Roof and Wall Cladding – Resistance to Wind Pressures for Cyclone Regions”.

AS 4040.0:1992 “Methods of testing sheet roof and wall cladding, Part 0: Introduction, list of methods and general requirements” requires that each different roof or wall cladding product (i.e. different profiles, thicknesses and so on) be tested for three different spans: a short span, an intermediate span, and a large span. Following testing, design wind strength load span tables for the tested panels can be created. These tables are valid for spans falling within the tested span range.[4]

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Choosing tried-and-tested facade systems

HVG Facades’ range of products are used in a wide variety of projects ranging from new builds to recladding applications across the residential, commercial, industrial, educational, aged care, healthcare and recreational sectors.

As a strong and successful business with a history dating back more than 50 years, HVG Facades is a dedicated supplier of a range of premium external cladding brands including MondoClad® and ZINTL®. These brands provide architects and designers with high-performance, non-combustible cladding solutions with compliance and safety in mind.

The company offers the security of product warranties, with an extensive range of products for new builds, or remedial and recladding applications. Their highly experienced team is here to support the ideas and aspirations of architects, property developers, designers and builders at every stage of the process.

Architects, builders, and engineers alike are increasingly concerned with the structural resilience of buildings and are placing a growing importance on making their constructions more durable and safer.

MondoClad® and ZINTL® have been tested to AS 4040 and are accompanied by wind load tables. The wind load tables provide a detailed summary of the suitability of each panel size or profile board based on specific project wind pressures and deflection criteria.

References

1 Designing Buildings Ltd. “Limit state design.” Designing Buildings: The Construction Wiki. https://www.designingbuildings.co.uk/wiki/Limit_state_design (accessed 31 March 2023).

2 School of Engineering and Physical Sciences. “Technical Note No.1 General Requirements for Testing Roof and Wall Cladding.” James Cook University. https://www.jcu.edu.au/__data/assets/pdf_file/0020/1171361/jcuprd-046084.pdf (accessed 31 March 2023).

3 Ibid.

4 Ibid.

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All information provided correct as of April 2023