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Are buildings ready for climate change?

Research shows that, apart from some slight changes, light timber-framed buildings designed using our current standards should largely stand up to the increased wind speeds that climate change is expected to bring.

IN *BUILD* 186, *Will our buildings stand climate change?* introduced a project exploring the potential effects of climate change on light timber-framed (LTF) buildings. This project considered wind speed increases and how they might affect the design of LTF buildings, considering several Aotearoa New Zealand building standards and an Acceptable Solution.

Do standards need to change?

The objective of the research was to understand how New Zealand building designs may need to adapt to climate change. A methodology for looking at climate change impacts was tested by looking at how well LTF buildings are placed in terms of resilience if climate change results in higher wind speeds.

The test case shows whether the New Zealand Building Code and referenced standards need to change or if there is sufficient conservatism included to accommodate changes in the environment and resulting increased loads on LTF buildings.

Storm clouds over Mt Eden, Auckland.

The project scope was intentionally limited to changes in wind speed on LTF buildings designed using NZS 3604:2011 *Timber-framed buildings*. This is the most widespread form of residential building in New Zealand, and wind loading is an important load case that could be evaluated with relative ease.

The project also served to test a methodology to determine if it would be appropriate for other types of buildings, standards and portions of the Building Code.

Four design standards analysed

Four design standards that are widely used for LTF buildings were looked at in the project:

- NZS 3604:2011
- NZS 4223.4:2008 *Glazing in buildings - Part 4: Wind, dead, snow, and live actions*
- NZS 4211:2008 *Specification for performance of windows*
- Building Code Acceptable Solution E2/AS1.

These were analysed to establish how changes in wind speed affect the design solutions for these buildings and the products and components used in them.

Design wind speed increases

Current wind speed projections resulting from climate change are variable over different timescales and across different regions in New Zealand. To overcome these uncertainties, a sensitivity analysis was used that determined the changes of design outputs resulting from increases in design wind speeds of 5%, 10% and 15%.

Estimated wind speeds from current climate change projections are well within the range of wind speed increases analysed for this project.

This approach was only applicable for NZS 3604:2011 and NZS 4223.4:2008, which are based on analytical methods. The analysis involved recreating selection tables from the standards that were identified as being affected by wind loads to see how spans (glass and timber), member sizes and connection details changed due to increased wind.

> Some changes to designs were required, but these would be minor in the dimensions and/or sizes of building members and components needed to resist an increase in the design wind speed.

NZS 4211:2008 and E2/AS1 provide solutions that are empirically developed and cannot be derived purely from engineering analysis. As such, the effects of changing input parameters such as wind speed on the design cannot be determined by calculation. However, the effects of increasing design wind speeds by 5%, 10% and 15% were evaluated by considering the impacts that such changes would have on the wind zones that are used in these standards.

LTF building standards well placed

In general, the project results suggest that New Zealand's LTF building standards are well placed to stand up to the impacts of increased wind speeds.

Some changes to designs were required, but these would be minor in the dimensions and/or sizes of building members and components needed to resist an increase in the design wind speed. The building costs associated with these minor changes are likely to be minimal.

Some components are already conservatively designed for use in all wind zones, so increasing wind speeds should have no significant effect.

Where SED will be required

It was noted that costs to building owners can increase if wind zone limits in the standards are exceeded, requiring specific engineering design (SED).

In these cases, the additional costs of SED arise from specialist design input and different building consent processes. Currently, only around 3% of existing properties are estimated to be zoned as SED.

Sensitivity analysis works well for some

The research has also shown that a method using sensitivity analysis works well for standards with an analytical basis, such as NZS 3604:2011 and NZS 4223.4:2008. Incremental changes in wind speeds could, in theory, be assessed for any projected change in the wind climate.

A key benefit of this method is that, as climate projections are updated or amended, the analysis remains valid. It can be easily applied to the most-current projections, and the results are not limited to a particular set of modelling assumptions or targets.

This project also confirmed that this approach cannot be applied universally. Design methods that incorporate empirically developed parameters and solutions require a comparative analysis to assess the impact of climate changes.

SED should account for climate change impacts

Generally, buildings constructed to non-specific design standards, such as NZS 3604:2011, are expected to have more inherent redundancy than specifically designed buildings. This is due to the prescriptive nature of these standards, which cover a limited range of building shapes and sizes. The need for a structural engineer who would otherwise optimise the design for the specific site is therefore reduced.

Analysis of the adaptation that might be needed for buildings that are specifically designed is more complex and was beyond the scope of this research.

Common design concepts and construction details would need to be identified to draw more-general conclusions about climate impacts on SED construction overall. However, because a specifically designed building is optimised for the specific conditions it is exposed to, climate change impacts could reasonably be expected to be accounted for in the design.

Further work as adaptation advances

As mentioned, this research has only looked at the impact of changes to wind on LTF buildings designed to NZS 3604:2011 as part of the overall adaptation needed for climate change.

As New Zealand firms up its plans around climate change adaptation, further work should be undertaken to complete the picture around the implications of other climate events on a wider range of buildings, such as multi-unit residential and commercial buildings.

Additional work for this project is under way to consider some more-specific implications of increased wind speeds on materials and costs for specific building designs.

For more A full report of findings will be available on the BRANZ website later this year – see www.branz.co.nz/pubs/research-reports.