Section 7:
Cost implications of changing the seismic hazard factor

The Z factor is the seismic hazard factor that is applied to a location. It is a fundamental value used to determine the design seismic actions for buildings.

## 7.1 Background

NZS 1170.5 sets out hazard factors: Z in Table 3.3 for cities and towns, and in a contour map of New Zealand on pages 18 and 19. The Z factor calculation is underpinned by the Natural Seismic Hazard Model, as discussed in section 2 of Volume 1 of this Report. The highest Z factor is 0.6 (Otira and Arthur’s Pass) while the lowest is 0.13 (a number of places including Auckland, Northland and Dunedin). Other examples are Wellington, Porirua and Hutt Valley at 0.40; Christchurch was 0.22 but it was raised to 0.30 after the earthquakes.

## 7.2 Introduction

The Z factor for Christchurch was increased to 0.30 after the earthquakes to take account of greater seismicity in the region. This change was made in consultation with GNS Science. Further work has been done by GNS since that time on the appropriate value for the seismic hazard factor for Christchurch, given the continuing seismic activity. This activity is expected to decrease over a period of decades (as discussed in section 2 of Volume 1). Further consideration is being given to the matter in the light of additional work on seismic hazards in the Christchurch region. At the time of writing the review of the Z value and the return factor for the servicability limit state are continuing.

The associated return period factor for the serviceability limit state was increased from 0.25 to 0.33. The return period factor and limit states are discussed in section 3 of Volume 1 of this Report.

## 7.3 Cost implications study

The Royal Commission considers it is important that the seismic hazard factor assigned to a place should provide an accurate reflection of the area’s earthquake hazard. However, it is also important not to overstate the hazard and thereby impose unjustified additional construction costs.

We have reviewed the structure of eight buildings with a view to ascertaining the cost implications of an increase in the Z factor. When we commenced this review, the Z factor and the associated return period factor for the serviceability limit state had been increased. However, during the Commission’s hearing on seismicity, GNS said further work on its seismic hazard model suggested a higher Z value, in the range of 0.34–0.39, with a corresponding return period factor for serviceability of 0.28.

For this reason we chose to assess cost implications for a hypothetical Z value of 0.35, except where a building had been redesigned already owing to the increase in Z factor to 0.30. In some cases, a major part of the cost increase came from the increased serviceability actions and the need to protect the building against damage associated with liquefaction in this limit state.

The buildings were all commercial structures ranging in size from one to 10 storeys, some with car parks. They were either built within the last 10 years or the subject of recently-issued building consents and not yet completed. They had a variety of foundation types and raised different geotechnical considerations. In some cases, it was apparent that a decision had been made to exceed the minimum requirements arising from the increased Z factor. A summary of the buildings’ attributes and the increase in construction costs is shown in the following table.

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| Increases in construction costs associated with higher Z factors for eight Christchurch buildings |
| Building | Characteristics | Z factor change | Increase in construction costs |
| 1 | Two levels: retail and car park | 0.30 to 0.35 | 1% |
| 2 | Three-level office building | 0.22 to 0.35 | 1% |
| 3 | 10-level office building plus two-level car park  | 0.22 to 0.35 | 2.6% |
| 4 | Single-level educational block | 0.22 to 0.35 | 1.1% |
| 5 | Three levels: two above ground, one basement  | 0.22 to 0.3 | 15.5% |
| 6 | Two-level government building | 0.22 to 0.35 | 4% |
| 7 | Three-level hostel | 0.22 to 0.3 | 7% |
| 8 | One-level supermarket plus basement car park | 0.22 to 0.3 | 5% |
| Note: building 5 required a complete re-design of foundations, whereas the other buildings generally required only additional steel and concrete to comply with the higher Z factor |

## 7.4 Discussion

While this is not a statistically significant sample, it provides an indication that construction costs do not generally appear to be significantly increased as a result of increases in the seismic hazard factor of the magnitude we have considered.

Overall, the incremental construction cost of building to a Z factor increased from 0.22 to 0.35 was less than five per cent, and in half the cases less than two per cent.

## 7.5 Conclusion

It is important that the seismic hazard factors adequately account for risk, but that they do not overstate it. Overall construction costs do not appear to significantly increase as a result of increases in the seismic hazard factor, based on the limited sample of buildings that were reviewed by the Royal Commission.