NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING

# Interim Advice for Seismic Isolation Design using TS 1170.5 or the SESOC Design Guide for NLRHA

**Interim addendum to the *NZSEE Guideline for the Design of Seismic Isolation Systems for Buildings***

**Version 0.1 DRAFT February 2025**

**Prepared by a study group of the NZSEE**

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# Purpose of this Draft Advisory

In 2019, a study group of the NZSEE released the *Guidelines for the Design of Seismic Isolation Systems for Buildings* (the *Isolation Guidelines*) as a draft for trial use. Having been applied in this form for about five years, NZSEE are now commencing an exercise to collect and compile feedback on the document, and scope any updates required to finalise it (with a view to then completing this work subject to securing funding). The anticipated release of TS 1170.5 provides some impetus for this work, as does the recent development of the *SESOC Design Guide for Non-linear Response History Analysis* (the *SESOC Design Guide for NLRHA*). The *Isolation Guidelines* would benefit from alignment with both documents.

The *Isolation Guidelines* include guidance on the selection and scaling of ground motion and the application of NLRHA techniques. **This interim advisory includes information supporting designers to apply the more contemporary ground motion selection and scaling approaches in the *SESOC Design Guide for NLRHA* (which have been reviewed for alignment with TS 1170.5), whilst otherwise following the design processes set out in the *Isolation Guidelines*** and generally maintaining the levels of performance intended by that document**.**

This interim advisory has been issued with draft status for the following reasons:

- To provide timely information on issues that require consideration for those designing seismic isolation systems (for buildings) using the *Isolation Guidelines*, and also wishing to consider the application of TS 1170.5 and the *SESOC Design Guide for NLRHA* (once these documents are published).
- In anticipation of a current proposal to update and finalise the *Isolation Guidelines* (which also has draft status currently). This interim advisory does not seek to change any of the performance settings associated with isolation system design to that document.
- To prompt feedback on the content within and issues related to NLRHA of seismically isolated structures, to inform the proposed review and alignment of the *Isolation Guidelines*, so that this feedback can be considered whilst finalising the document.

## KEY MESSAGES

- **This interim advisory provides information on the use of TS 1170.5 and the *SESOC Design Guide for NLRHA*, (once both documents are finalised) specifically in their application to seismically isolated buildings otherwise designed using the *2019 NZSEE Guidelines for the Design of Seismic Isolation Systems for Buildings | Draft for Trial Use* (the *Isolation Guidelines*).**
- The draft DZ TS 1170.5:2024, and a draft version of the *SESOC Design Guide for NLRHA* were circulated for public comment in 2024. Neither document should be used for design until published in their final form.
- Once published, use of the documents would constitute an alternative solution for compliance with Building Code Clause B1. See the introduction sections of the *Isolation Guidelines* and the *SESOC Design Guide for NLRHA* for further commentary.
- The suggested approach in this advisory deliberately intends to maintain comparable levels of performance to the *Isolation Guidelines* for a given level of seismic hazard, as near as is practicable.

# Nonlinear Response History Analysis (NLRHA) for Structures with Seismic Isolation

## SELECTING AN APPROPRIATE NLRHA METHOD

### Considerations when selecting a NLRHA method for design of isolated structures

Designers of isolated structures (buildings) that intend to validate the design using NLRHA need to consider what method will be most appropriate. Guidance is given in the *Isolation Guidelines*. However, use of the method in the *SESOC Design Guide for NLRHA* is likely to have some benefits—especially where TS 1170.5 is being considered. These include:

- A more contemporary NLRHA method that is better aligned with approaches internationally, and that benefits from knowledge gained since the publication of NZS 1170.5:2004 (and the draft release of the *Isolation Guidelines*). Refer to the *SESOC Design Guide for NLRHA* for further discussion and references.
- Allows the adoption of target spectra for seismic demand which are better suited to longer period and seismically isolated structures (and which better account for some of the limitations of NZS 1170.5:2004 design spectra that are discussed in Chapter 4 of the *Isolation Guidelines*).

It is important to recognise that a complete NLRHA method works in conjunction with the type of seismic demand information. For example, in the *SESOC Design Guide for NLRHA*, ground motion scaling is carried out in the geometric mean domain, which is consistent with the basis for design spectra in TS 1170.5 (which are based on the geometric mean). If NZS 1170.5:2004 were used as the target spectra, appropriate adjustments would need to be made to the process to avoid an inconsistent approach.

> The NLRHA analysis method is one of a number of methods that can be used for determining earthquake demands on structures and their components. In principle, given an assessment of the demands, the required capacity and performance of the system can be determined using the *Isolation Guidelines*. However, for isolated structures, and specifically when considering the performance and displacement capacity of the isolation plane, methods of deriving demands from NLRHA and the isolation system's capacity and overall reliability are interrelated.

# Using the SESOC Design Guide for NLRHA

When using the method set out in the *SESOC Design Guide for NLRHA*, designers should consider the following clarifications in its application to validating the design of seismic isolation systems for buildings.

## PERFORMANCE OBJECTIVES, GROUND MOTION INPUT, AND MODELLING

### Performance Objectives and Limit States

The performance limit states and the associated hazard levels defined in the *Isolation Guidelines* can continue to be used. This includes the defined Collapse Avoidance Limit State (CALS), the ULS hazard multipliers associated with the CALS, the extent of CALS review, and the use of the robustness factor $\alpha$. The CALS hazard multiplier defined in the *SESOC Design Guide for NLRHA* does not apply to buildings with seismic isolation. Instead, refer to section 4.2.4 of the *Isolation Guidelines*.

### Period Range of Interest for Amplitude Scaling

Both ASCE 7-22 and the *Isolation Guidelines* have information on appropriate modifications to the period range of interest for amplitude scaling of isolated structures, and useful commentary describing the issues.

### Damping

Target elastic equivalent viscous damping for seismically isolated structures can be determined in accordance with Section 4.2 of the *SESOC Design Guide for NLRHA*. Otherwise, designers should refer to the *Isolation Guidelines* and the literature for more information on the application of damping in the analysis of seismically isolated structures.

## DISPLACEMENTS AND FORCES FOR ISOLATION SYSTEM DESIGN

### Deriving Displacement Demands from NLRHA

For setting rattle space dimensions and the required travel of bearings, and assuming the impacts of contact with a displacement restraining system or moat (exhaustion of rattle space) are *not* explicitly modelled (expected to be the approach generally), the following behaviours should be treated as force-controlled:

- Displacements at contact with a moat or restraining system[1]: force-controlled (non-critical)
- Exceeding range of sliding bearings (overlap reduces to maximum bearing pressure)[2]: force-controlled (non-critical)
- Isolator fixings to structure[2]: force-controlled (non-critical)

Although the evaluation of the first two items may be related to isolation system *displacement*, the treatment of a step-change in behaviour once displacement range is exhausted (which would extend beyond the 'valid range of modelling') is considered comparable to a force-controlled action. This recommendation ensures consistency with the methods set out in the *SESOC Design Guide for NLRHA*. The exceedance of isolation system range or available rattle space in an individual ground motion does not need to be considered an *unacceptable response*.

[1] Restraining systems include retainer rings of sliding isolators, engaging a stiffening regime of an isolator device, or the activation of any other device intended to arrest the displacement of individual isolators or the isolation system as a whole.

[2] Exception: Where isolator displacements are constrained by the presence of a structure around the moat perimeter with sufficient stiffness and strength to effectively limit displacements, then isolators and their fixings to structure need not be designed to accommodate displacements greater than this amount (provided that sliding bearings do not overlap their sliding surfaces). The vectoral displacements of isolators in all directions should be considered.

The above behaviours are characterised as force controlled (non-critical), meaning a strength reduction factor $\phi = 1.0$ can be used—the robustness factor sufficiently captures consequence of failure. The factor $\gamma$ (equal to 1.3) allows for record-to-record variability in demand, as described in the *SESOC Design Guide for NLRHA*. For isolation system displacements, assuming that gravity displacements are zero, the CALS limit for isolation system range simplifies to:

$$\gamma E_d \leq R_n$$

where $E_d$ is the displacement demand determined from the suite of ground motions according to the NLRHA guidelines with $\alpha$ applied to ground motion scaling (from the *Isolation Guidelines*), and $R_n$ is the capacity (in this case the isolation system displacement limit, or the nominal capacity of fasteners).

As stated above, the exceedance of isolation system range or available rattle space in an individual ground motion does **not** need to be considered an *unacceptable response*. It is difficult and usually impractical (when applying the methods given in the *SESOC Design Guide for NLRHA* in a design office setting) to enforce enough control over record-to-record variability for individual ground motion results (or their dispersion) to be reliable indicators of demand variability. Therefore, it is less likely to be appropriate for an *unacceptable response* requirement on individual ground motions to determine such an important and sensitive design parameter as the displacement capacity (and rattle space) of an isolation system.

Instead, it is preferable (and considerably more practical) to apply a constant factor ($\gamma$) to a mean or median value (whichever is applicable) to account for demand variability. Overall, this maintains a comparable performance setting to the current version of the *Isolation Guidelines*. Some illustrative comparative examples in support of this statement are given in Appendix A. This aspect of NLRHA on isolated structures continues to be a live topic of discussion internationally.

*Unacceptable response* should continue to be considered in other components of isolated structures, in accordance with the *SESOC Design Guide for NLRHA*.

For both rattle space dimensions and for determining the required travel capacity of bearings, it is recommended that the demand parameter $E_d$ be based on the maximum vectoral displacement. Assuming no unacceptable response, this would be the mean value of the maximum vectoral displacement obtained from each ground motion in the suite.

### The robustness factor

Most systems will have some residual capacity beyond the displacement limits defined above. The robustness of the combined system and reliability in performance beyond this point depends on its configuration, and it is difficult to determine numerically. This is managed implicitly by the *Isolation Guidelines'* robustness factor, which should continue to be applied.

The *Isolation Guidelines* robustness factor $\alpha$ is representative of implicit residual *capacity* beyond the evaluated performance point (displacement limit). However, it can continue to be applied as a CALS *demand* reduction in the way that the *Isolation Guidelines* apply it.

For isolator design and performance specification, and for isolator stability structure, the robustness factor should generally be determined assuming the system is *not* constrained by the presence of a moat. However, where a moat around the full building perimeter is available *and* has sufficient stiffness and strength to effectively arrest displacements in all directions, then isolators and their fixings to structure (and isolator stability structure) need not be designed to accommodate displacements greater than that amount (provided that sliding bearings do not overlap their sliding surfaces). The vectoral displacements of isolators in all directions should be considered, as for some building outlines, the available displacement before moat contact may be greater in off-orthogonal directions.

# Appendix A: Example Demand Comparisons

For illustrative purposes only, the below example tables have been prepared to provide a high-level comparison of the likely isolation plane displacement demands obtained from the application of the following NLRHA approaches:

- The *Isolation Guidelines* (applied with NZS 1170.5:2004) but using a mean scaling approach.
- The *Isolation Guidelines*, applied in conjunction with the *SESOC Design Guide for NLRHA* method and this advisory.
- ASCE 7-22, Chapter 17, using the non-linear dynamic analysis procedure.

The comparisons assume a constant underlying seismic hazard and list the pertinent contributors.

The comparison tables acknowledge the difference between CALS hazard level as defined in New Zealand approaches, and the risk-targeted $MCE_R$ used in US approaches—but do not attempt to further quantify this relativity beyond a coarse comparison of the return periods. The tables also consider the demand obtained from the modified NZS 1170.5:2004 scaling procedures in the *Isolation Guidelines* (generally carried out in the $SA_{larger}$ domain) to be generally comparable to scaling approaches carried out in the RotD50 or RotD100 domains (with compatible target spectra) for the purposes of these comparisons.

## Comparison outcomes

For a constant underlying hazard (and noting the limitations stated above), the tables indicate that comparable isolation system performance should be expected between designs validated using NLRHA to the *Isolation Guidelines*[1] and using the approach set out in this advisory (application of the *Isolation Guidelines* with the *SESOC Design Guide for NLRHA*).

There is also reasonably comparable performance with ASCE 7-22 for “ordinary” buildings (Importance Level 2). However, the New Zealand approach currently requires a relativity to be maintained across importance levels that is similar to conventional fixed base structures. This approach is maintained, and therefore differs to ASCE 7.

[1] The following paper investigates the collapse and loss performance of base isolated buildings designed to the *Isolation Guidelines*, and may be of interest to readers: Dong, C. Sullivan, T. J., Pettinga, D. (2024) *Investigating the Impacts of Design Ductility Values and Importance Levels on the Performance of Base-Isolated Buildings in New Zealand*. Bulletin of the New Zealand Society for Earthquake Engineering (accepted October 2024). https://doi.org/10.5459/bnzsee.1693

## Examples for Importance Level 2 Isolated Buildings

*Table 1: Required dimensions of rattle space for ductile superstructures (bracketed value applies to brittle superstructures)*

| Parameter | Isolation Guidelines, NLRHA, mean scaling | Isolation Guidelines and this advisory (SESOC Design Guide: NLRHA) | ASCE 7-22 Chpt. 17 NLRHA (NDP) Method |
|---|---|---|---|
| $S_p$ adjustment | 1.0 | 0.85 | - |
| Method of computing $E_d$ from GM suite | mean | | |
| Method of GM scaling and application, $E_d$ represents (far field): | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken. | | |
| Demand variability, $\gamma$ | - | 1.3 | - |
| CALS hazard (excl. $\alpha$) | 1/500 x 1.5 | 1/500 x 1.5 | 1/2500 (risk-targeted) |
| $1 / \alpha$ | 0.83 (1.0) | 0.83 (1.0) | 1 |
| COM or extremities | Extremities | Extremities | Extremities |
| Demand rel. to Isolation Guidelines[1] | 100% | **110%** | **120% (100%)** |

Note 1: Comparisons are based on rows 1, 4 and 6 only ($S_p$, demand variability, and $\alpha$).

Note 2: Where the moat perimeter has sufficient stiffness and strength to effectively arrest displacements, then isolators and their fixings to structure (and isolator stability structure) need not be designed to accommodate displacements greater than that amount (provided that sliding bearings do not overlap their sliding surfaces). The vectoral displacements of isolators in all directions should be considered (as the available displacement may be greater in off-orthogonal directions).

*Table 2: Required displacement capacity of a LRB device with unconstrained displacement*

| Parameter | Isolation Guidelines, NLRHA, mean scaling | Isolation Guidelines and this advisory (SESOC Design Guide: NLRHA) | ASCE 7-22 Chpt. 17 NLRHA (NDP) Method |
|---|---|---|---|
| $S_p$ adjustment | 0.85[2] (1)[3] | 0.85 | - |
| Method of computing $E_d$ from GM suite | mean | | |
| Method of GM scaling and application, $E_d$ represents (far field): | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken. | | |
| Demand variability, $\gamma$ | - | 1 (1.3)[3] | - |
| CALS hazard (excl. $\alpha$) | 1/500 x 1.5 | 1/500 x 1.5 | 1/2500 (risk-targeted) |
| $1 / \alpha$ | 1[4] | 1[4] | 1 |
| COM or extremities | Extremities | Extremities | Extremities |
| Demand rel. to Isolation Guidelines[1] | 100% | **100% (110%)[3]** | **120% (100%)[3]** |

Note 1: Comparisons are based on rows 1, 4 and 6 only ($S_p$, demand variability, and $\alpha$).

Note 2: Where CALS strain factors ≥ 1.2, $S_{p,iso}$ = 0.7 according to the Isolation Guidelines; otherwise 1.0.

Note 3: Bracketed value denotes values applicable to isolator fixings and isolator stability structure.

Note 4: This value applies to brittle structures or where the superstructure could fall more than a bearing height in the event of bearing damage or failure. Where a non-brittle superstructure would fall less than a bearing height and maintain a vertical load path, a value of 1 / 1.1 = 0.9 applies. Refer Table 2-2 of the *Isolation Guidelines*.

*Table 3: Required displacement capacity of a sliding bearing with unconstrained displacement*

| Parameter | **Isolation Guidelines,** NLRHA, mean scaling | **Isolation Guidelines and this advisory** (SESOC Design Guide: NLRHA) | **ASCE 7-22 Chpt. 17** NLRHA (NDP) Method |
|---|---|---|---|
| **$S_p$ adjustment** | 1.0 | 0.85 | - |
| **Method of computing $E_d$ from GM suite** | mean | | |
| **Method of GM scaling and application, $E_d$ represents (far field):** | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken. | | |
| **Demand variability, γ** | - | 1.3 | - |
| **CALS hazard (excl. α)** | 1/500 x 1.5 | 1/500 x 1.5 | 1/2500 (risk-targeted) |
| **1 / α** | 1[3] | 1[3] | 1 |
| **COM or extremities** | Extremities | Extremities | Extremities |
| **Demand rel. to Isolation Guidelines[1]** | 100% | **< 110% [2]** | **100%** |

Note 1: Comparisons are based on rows 1, 4 and 6 only ($S_p$, demand variability, and α).

Note 2: '<' indicates that this advisory permits some bearing overlap until maximum bearing pressure is reached (where displacement is being limited as a 'force-controlled' behaviour).

Note 3: This value applies to brittle structures or where the superstructure could fall more than a bearing height in the event of bearing damage or failure. Where a non-brittle superstructure would fall less than a bearing height and maintain a vertical load path, a value of 1 / 1.1 = 0.9 applies. Refer Table 2-2 of the *Isolation Guidelines*.

## Examples for Importance Level 4 Isolated Buildings

*Table 4: Required dimensions of rattle space for ductile superstructures (bracketed value applies to brittle superstructures)*

| Parameter | **Isolation Guidelines,** NLRHA, mean scaling | **Isolation Guidelines and this advisory** (SESOC Design Guide: NLRHA) | **ASCE 7-22 Chpt. 17** NLRHA (NDP) Method |
|---|---|---|---|
| **$S_p$ adjustment** | 1.0 | 0.85 | - |
| **Method of computing $E_d$ from GM suite** | mean | | |
| **Method of GM scaling and application, $E_d$ represents (far field):** | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken. | | |
| **Demand variability, γ** | - | 1.3 | - |
| **CALS hazard (excl. α)** | 1/2500 x 1.3 | 1/2500 x 1.3 | 1/2500 (risk-targeted) |
| **1 / α** | 0.83 (1.0) | 0.83 (1.0) | 1 |
| **COM or extremities** | Extremities | Extremities | Extremities |
| **Demand rel. to Isolation Guidelines[1]** | 100% | **110%** | **95% (75%)** |

Note 1: Comparisons are based on rows 1, 4-6 only ($S_p$, demand variability, CALS hazard and α).

Note 2: Where the moat perimeter has sufficient stiffness and strength to effectively arrest displacements, then isolators and their fixings to structure (and isolator stability structure) need not be designed to accommodate displacements greater than that amount (provided that sliding bearings do not overlap their sliding surfaces). The vectoral displacements of isolators in all directions should be considered (as the available displacement may be greater in off-orthogonal directions).

*Table 5: Required displacement capacity of LRB with unconstrained displacement*

| Parameter | **Isolation Guidelines,** NLRHA, mean scaling | **Isolation Guidelines and this advisory** (SESOC Design Guide: NLRHA) | **ASCE 7-22 Chpt. 17** NLRHA (NDP) Method |
|---|---|---|---|
| **$S_p$ adjustment** | 0.85[2] (1)[3] | 0.85 | - |
| **Method of computing $E_d$ from GM suite** | mean | | |
| **Method of GM scaling and application, $E_d$ represents (far field):** | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken. | | |
| **Demand variability, γ** | - | 1 (1.3)[3] | - |
| **CALS hazard (excl. α)** | 1/2500 x 1.3 | 1/2500 x 1.3 | 1/2500 (risk-targeted) |
| **1 / α** | 1[4] | 1[4] | 1 |
| **COM or extremities** | Extremities | Extremities | Extremities |
| **Demand rel. to Isolation Guidelines[1]** | 100% | **100% (110%)[3]** | **90% (75%)[3]** |

Note 1: Comparisons are based on rows 1, 4-6 only ($S_p$, demand variability, CALS hazard and α).

Note 2: Where CALS strain factors ≥ 1.2, $S_{p,iso}$ = 0.7 according to the Isolation Guidelines; otherwise 1.0.

Note 3: Unbracketed values Bracketed value denotes values applicable to isolator fixings and isolator stability structure.

Note 4: This value applies to brittle structures or where the superstructure could fall more than a bearing height in the event of bearing damage or failure. Where a non-brittle superstructure would fall less than a bearing height and maintain a vertical load path, a value of 1 / 1.1 = 0.9 applies. Refer Table 2-2 of the *Isolation Guidelines*.

*Table 6: Required displacement capacity of a sliding bearing with unconstrained displacement*

| **Parameter** | **Isolation Guidelines,** NLRHA, mean scaling | **Isolation Guidelines and this advisory** (SESOC Design Guide: NLRHA) | **ASCE 7-22 Chpt. 17** NLRHA (NDP) Method |
|---|---|---|---|
| **$S_p$ adjustment** | 1.0 | 0.85 | - |
| **Method of computing $E_d$ from GM suite** | mean | | |
| **Method of GM scaling and application, $E_d$ represents (far field):** | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken. | | |
| **Demand variability, $\gamma$** | - | 1.3 | - |
| **CALS hazard (excl. $\alpha$)** | 1/2500 x 1.3 | 1/2500 x 1.3 | 1/2500 (risk-targeted) |
| **1 / $\alpha$** | 1[3] | 1[3] | 1 |
| **COM or extremities** | Extremities | Extremities | Extremities |
| **Demand rel. to Isolation Guidelines[1]** | 100% | **< 110%** [2] | **75%** |

Note 1: Comparisons are based on rows 1, 4-6 only ($S_p$, demand variability, CALS hazard and $\alpha$).

Note 2: '<' indicates that this advisory permits some bearing overlap until maximum bearing pressure is reached (where displacement is being limited as a 'force-controlled' behaviour).

Note 3: This value applies to brittle structures or where the superstructure could fall more than a bearing height in the event of bearing damage or failure. Where a non-brittle superstructure would fall less than a bearing height and maintain a vertical load path, a value of 1 / 1.1 = 0.9 applies. Refer Table 2-2 of the *Isolation Guidelines*.

## Comparing the required displacement demands for isolators and rattle space design

This table applies to NLRHA validation of an isolated building designed using the *Isolation Guidelines* in conjunction with the *SESOC Design Guide for NLRHA* and this advisory. It illustrates the parameters that would be applicable to different components of the isolation system, and it assumes that the superstructure in this example is ductile.

*Table 7: Required rattle space dimension and required displacement capacity of bearings, for a base isolated ductile superstructure designed to the Isolation Guidelines and this advisory*

| **Parameter** | **Rattle space**[3] ductile superstructure | **LRB** (bracketed value applies to fasteners) | **Sliding Surface** |
|---|---|---|---|
| **$S_p$ adjustment** | 0.85 | | |
| **Method of computing $E_d$ from GM suite** | mean | | |
| **Method of GM scaling and application, $E_d$ represents (far field):** | Generally, $E_d$ approximates the geometric mean demand for parameters that are direction dependent. The maximum direction demand on isolators is obtained where the mean of peak vectoral displacements for each ground motion is taken.<br>It is recommended that the mean of peak vectoral displacements be taken. | | |
| **Demand variability, γ** | 1.3 | 1 (1.3) | 1.3 |
| **1 / α** | 0.83 | 1[2] | 1[2] |
| **COM or extremities** | Extremities | Extremities | Extremities |
| **Demand rel. to min. rattle space dimension** | 100% | **90% (115%)** | **< 120%**[1] |

Note 1: ‘<’ indicates that this advisory permits some bearing overlap until maximum bearing pressure is reached (where displacement is being limited as a ‘force-controlled’ behaviour).

Note 2: Where the superstructure could fall more than a bearing height if a bearing’s capacity was exceeded.

Note 3: This column also applies to contact or engagement with a restraining device.