

**Objectives, status, and future of
the 2006 NZSEE Guidelines on
"Assessment and Improvement of the
Structural Performance of Buildings in
Earthquakes"**

**a submission to the Royal Commission of Inquiry
into the Canterbury Earthquakes**

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Structural Fragility Curve

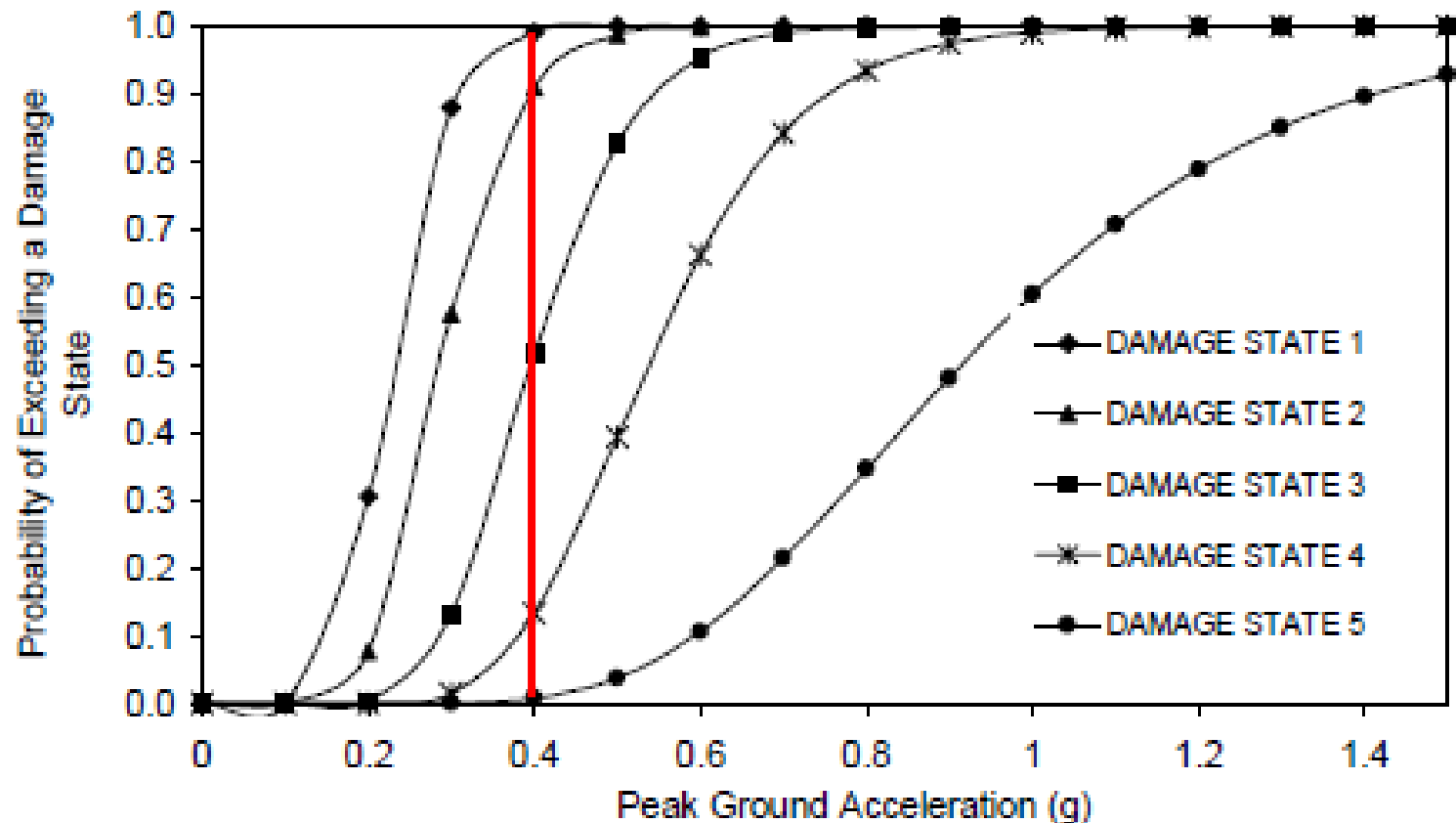


Table 5.2 (a) Event Effects - General

Impact Measure ==>	0%	5 - 10 %	10 - 20 %	20 - 40%	40 - 60%	60 - 80%	80 - 100%
Severity ==>	Insignificant	Mild	Moderate	High	Severe	Very Severe	Extreme
Access / Egress	Ready and safe access / egress possible	Ready and safe access / egress possible	Restricted, but manageable, access to / egress from some areas.	Difficult to access many areas, dangerous to access some. Disabled access not possible, disabled egress possible with assistance.	Access possible only for emergency personnel. Egress for many possible only with assistance.	Access or egress possible only with specialised equipment.	Access or egress not possible without heavy lifting equipment or removal of debris.
Occupant harm (injury)	No injuries or fatalities	Very low injury rate. No fatalities.	Less than 10 hospitalised for injury. No more than one fatality.	Less than 30 hospitalised for injury. No more than three fatalities.	More than 30 hospitalised for injury. More than three fatalities.	More than 100 hospitalised for injury. More than 10 fatalities.	More than 300 hospitalised for injury. More than 30 fatalities.
Wellbeing	No noticeable impact	Wellbeing/amenity of building users reduced by 10%	Wellbeing/amenity of building users reduced by 10%	Wellbeing/amenity of building users reduced by 30%	Wellbeing/amenity of building users reduced by 50%	Wellbeing of building users reduced by 80%	Wellbeing of building users reduced by 100%
Occupant health (illness)	No adverse impact	Illness restricted to those occupying the facility, and affecting less than 10% of occupants	Illness restricted to those occupying the facility, and affecting less than 50% of occupants. Medical intervention may be required.	Illness widespread amongst those occupying the facility, and affects others within 5 kilometres. Medical intervention and hospitalisation of some cases is necessary.	Illness widespread amongst those occupying the facility, and affects others over a wide area. Medical intervention and/or hospitalisation many cases necessary. High likelihood of single life loss and moderate likelihood of multiple life loss.	Illness widespread and affects others-suburb-wide. Multiple deaths	Illness widespread and affects others-city-wide.
Environmental Impacts	No impact beyond Resource Consent levels	Environment able to recover within months	Recovery of environment possible within a few years.	Recovery of environment possible within a few decades.	Recovery of environment possible over many decades.	Significant parts of environment destroyed or permanently altered	Large parts of environment destroyed or permanently altered
Resources for Reinstatement	None	Less than 25% of community norm.	Up to 50% of community norm.	More than 50% of community norm.	More than 100% of community norm.	More than 2 times the community norm.	More than 3 times the community norm.



Table 5.2 (b) Event Effects - Structural

Impact Measure ==>	0%	5 - 10 %	10 - 20 %	20 - 40%	40 - 60%	60 - 80%	80 - 100%
Severity ==>	Insignificant	Mild	Moderate	High	Severe	Very Severe	Extreme
Structure	No damage.	No damage to major elements. Minimal damage to other structural elements. Building safe to occupy.	Some major and other elements damaged but repairable. No significant safety concerns or structural degradation.	Many major elements damaged. Some falling debris. Repair possible. Safety of structure requires professional assessment before being fit for occupancy. Some degradation possible. Permanent displacements may be evident.	Extensive damage to major structural elements. Significant falling debris. Repair extensive but possible. Structure and building clearly unsafe and not fit for occupancy. Significant structural degradation and permanent displacements evident.	Very extensive damage to major structural elements. Collapse of significant parts of the building. Some parts worth repairing but many have to be replaced.	Collapse of major parts of the building. No part of building is worth repairing.
Building fabric (“non-structure” such as walls, ceilings, glazing, finishes, fittings)	No damage	Superficial damage only. Repair in-situ possible without removal of items. Building habitable with no significant concerns	Damage to about 15% of elements which may require removal for repair or replacement. Functionality impaired but building habitable	Damage to about 30% of elements, requiring extensive repairs or replacement. Building overall not habitable without emergency measures or repair / reinstatement. Some danger from falling objects or loss of barriers.	Damage to about 50% of elements requiring replacement in most cases. Building dangerous and not suitable for occupancy without major work. Danger from falling objects and loss of barriers.	About 70% of building fabric damaged and beyond repair. Building dangerous and not suitable for occupancy. Likely to be demolished and replaced.	80 to 100% of building fabric damaged and beyond repair. Building dangerous and not suitable for occupancy. Almost certain to be demolished and replaced.
Building services and facilities (eg pipes, toilets, elevators, HVAC, power systems, water supplies, fire protection systems)	Systems all operational	All systems fully operational but at 50% capacity.	Essential systems remain operational. Normal operating systems are inoperative or working at less than 50% capacity for up to 7 day.	Emergency systems slightly damaged, but remain 90% operational. Normal operating systems are inoperative or working at less than 50% capacity for up to 7 day.	Emergency systems including egress damaged & operate at 75% capacity. Systems needed for normal building or facility use are significantly damaged and inoperable. Repairable within 30 days.	Emergency systems substantially damaged and non-functional. Egress routes impaired (<50% capacity). Systems needed for normal building use completely non-functional. Systems such as primary electrical power and ventilation may be inoperable. Repairable within 3 months.	Extensive damage. No functionality. Most elements / systems not repairable. Function restored only by replacement.
Major Plant and Equipment	Systems all operational	All systems remain fully operational but capacity reduced to 75% capacity for <1 week through disruption of supply (water/power/controls).	Essential plant remains fully operational. Other systems slightly damaged with capacity reduced to 50% for <1 week.	Essential plant remains fully operational so as enable controlled plant shut-down. Other systems damaged with capacity reduced up to 50% for <4 week.	Essential plant remains fully operational. Other systems damaged to the extent that controlled shut down for up to 4 weeks required. Most plant items can be brought back into operation.	Essential plant remains fully operational sufficiently to allow safe shutdown. Other systems damaged to with 75% requiring replacement. Operations disrupted for up to 12 months.	Extensive damage. System failure such that safe shut down no longer assured. Most elements / systems not repairable. Function restored only by replacement.
Bridges, Wharves, etc?	No damage.	No damage to primary structural elements. Minimal damage (cracking or tilting) to other structural elements and/or abutments. Facility safe to use.	Some superficial damage to primary structure. Other elements damaged but repairable. Facility continues to operate perhaps at reduced capacity. No significant safety concerns.	Many primary elements damaged with some residual deformations but repairs practical. Safety of structure in doubt with safe evacuation possible pending professional assessment. Adjoining accessways compromised with cracking and surface damage significantly reducing safe access.	Extensive damage to major structural elements. Repair extensive but possible. Structure clearly unsafe and not fit for use. Significant structural degradation and permanent displacements evident.	Very extensive damage to major structural elements. Collapse of significant parts. Some parts worth repairing but many have to be replaced.	Collapse of major parts of the structure. Replacement required rather than repair.
Lifelines	No damage.	No damage to major elements. Minimal damage to other secondary elements. Lifeline operational and safe to use.	Primary elements undamaged; Some secondary elements damaged but repairable. No significant safety concerns. Interruption to services for up to 7 days.	Some primary elements damaged; Secondary elements moderately damaged but repairable. No direct safety concerns. Capacity immediately reduced to <50%; Full service restored after 30 days.	Many primary and most secondary elements damaged. <25% replacement required. Some immediate safety concerns. Capacity immediately reduced to <25%; Full service restored after 3 months.	Most lifelines are seriously damaged and not functioning many beyond repair. Service restored within one year.	All or almost all lifelines seriously damaged. Services and not functioning. Service restored within three years.
Ground and foundations, Earth structures	No damage.	No damage to major elements. Minimal evidence of movement. No safety concerns.	Some major and other elements damaged but repairable. No significant safety concerns or structural degradation. Permanent displacements of ground may be evident.	Major elements damaged. Repair possible. Safety of structure requires professional assessment. Significant structural degradation. Permanent displacements of ground evident.	Significant damage to major structural elements. Repair extensive but possible. Structure clearly unsafe and not fit for normal use. Serious structural degradation. Large permanent displacements of ground.	Extensive damage to major structural elements. Structural integrity lost. Major permanent displacements of ground evident. Structure clearly unsafe. Collapse may be likely. Repair possible but not economic.	Serious damage to most. If not all, structural elements. Collapse of part or all of the structure. Very large permanent ground displacements evident. Structure clearly unsafe. Repair not economic.
Hazardous materials	Hazardous materials adequately contained	Hazardous materials adequately contained	Hazardous material release confined to part of the building	Hazardous material release confined to the building	Hazardous material release confined within the property boundaries.	Uncontrolled release of small volumes of hazardous contents into the environment.	Complete release of sufficient volumes of hazardous contents into the environment to require neighbourhood evaluation.
Contents	No damage	Damage to most contents is of minor nature (eg a few unrestrained items falling from shelves). Overall extent and cost is minor. (Less than 10% of replacement)	Damage to contents is moderate in nature, with many unrestrained items falling from shelves and some heavier items becoming dislodged or sliding short distances across the floor. Overall extent and cost is moderate.	Damage to contents is extensive. Many items fallen from shelves, some heavy unrestrained cupboards sliding or toppling damaging themselves, their contents of surrounding items some as a total loss.	Many shelves have shed their contents with fallen items damaged beyond repair. Some furniture damaged either by toppling or fallen items. Most items irretrievable (often as a consequence of the building being unsafe to enter except to retrieve selected items of value).	All shelves have shed their contents, widespread furniture damage, many fallen items damaged beyond repair. Building envelope compromised. Many items irretrievable before extensive weather damage experienced.	Contents are irretrievable (often as a consequence of the building being destroyed or unsafe to enter) and therefore a total or near-total loss.
Fire (Explosion)	No fire caused	No fire caused	Damage restricted to room of origin. Superficial effect on structural members requiring inspection and repair	Damage restricted to subject building	Damage affects subject building significantly and neighbouring buildings	Whole building affected. Possible collapse of whole building	Whole building seriously affected. Collapse of whole or major part of building likely



Tolerable Impacts - Structural

ENG.NZSEE.0005.5

Event Definition (Annual Probability)				Chances of Event Occurring	Performance Group				Earthquake Intensity Factor from AS/NZS 1170 (for reference purposes only)		
Volcanic Activity	Snow / Ice	Wind	Earthquake		1	2	3	4			
Note: Values shown are indicative only											
1/5000	1/500	1/2500	1/2500	Extremely Low		Impact Level 6 (Extreme)	Impact Level 5 (Very Severe)	Impact Level 5 (Very Severe)	1.8		
1/2000	1/250	1/500	1/1000	Very Low	Impact Level 6 (Extreme)	Impact Level 5 (Very Severe)	Impact Level 4 (Severe)	Impact Level 4 (Severe)	1.3		
1/1000	1/150	1/500	1/500	Low	Impact Level 5 (Very Severe)	Impact Level 4 (Severe)	Impact Level 3 (High)	Impact Level 2 (Moderate)	1.0		
1/500	1/50	1/100	1/100	Medium	Impact Level 4 (Severe)	Impact Level 3 (High)	Impact Level 2 (Moderate)	Impact Level 1 (Mild)	0.5		
1/25	1/25	1/25	1/25	High	Impact Level 2 (Moderate)	Impact Level 1 (Mild)	Impact Level 1 (Mild)	Impact Level 1 (Mild)	0.3		
"Everyday"					Impact Level 0 (Insignificant)	Impact Level 0 (Insignificant)	Impact Level 0 (Insignificant)	Impact Level 0 (Insignificant)	0.0		
					Impact Level 0 (Insignificant)	Impact Level 0 (Insignificant)	Impact Level 0 (Insignificant)	Impact Level 0 (Insignificant)			
Key to Impact Levels <i>(It is expected that no more than 10% of buildings would have the level of impact stated)</i>					Impact Level 0 Insignificant	Impact Level 1 Mild	Impact Level 2 Moderate	Impact Level 3 High	Impact Level 4 Severe	Impact Level 5 Very Severe	Impact Level 6 Extreme
					No significant effects on building elements, occupants or functions (Compare SLS 2)	Building function maintained. Little or no damage to structure. Minor damage to building fabric. Some contents affected. Building fully accessible and safe to occupy. No damage. No downtime. No deaths. No injuries.	Building function affected for less than 1 hour. Minor damage to structure. Moderate damage to building fabric. Contents affected. Building accessible and safe to occupy. (Compare SLS 2) No deaths. Injuries unlikely.	Building function affected for up to 7 days. Moderate, but repairable damage to structure. Damage to building fabric requires replacement of some items. Most contents affected. Access inhibited. Most of building safe to occupy after clearance by authorities. Deaths unlikely. Low number of injuries	Building unsafe to occupy for up to one year. Major damage to structure and building fabric, but capable of repair. Most contents seriously affected. Building function extensively affected. Unassisted evacuation possible. Some deaths likely. Moderate number of injuries	Building unsafe to occupy for one year or more. Major and extensive damage to structure and building fabric. Not repairable. Contents not salvageable. Access denied for an indefinite period. Building function ceases. Moderate number of deaths. High number of injuries.	Building collapse. High number of deaths and injuries.

