DAMAGE ASSESSMENT FOR RESIDENTIAL STRUCTURES FOLLOWING EARTHQUAKES

The Canterbury earthquakes have subjected many houses to forces far greater than anticipated when they were first designed, resulting in considerable visible and hidden damage to structure and finishes. To ensure effective repairs, damage must be assessed accurately. This guide aims to assist the assessment process and with deciding the most appropriate corrective action.

SAFETY

Always ensure personal safety and safety of others. Follow Site Safe practices and your company's safety instructions. Be particularly aware of hazards when entering earthquake damaged structures.

SITE

Note general observations such proximity of the site to slopes, water ways, etc. and ground conditions including any movements such as, driveway cracks, slopes, liquefaction, etc.

HOUSE TYPE

Record house and site information as illustrated in the model checklist below. Add any notes peculiar to the site and structure visited. A concise photographic record is recommended.

PILED FOUNDATIONS

Check building and floor levels. Bearers can move on piles and joists can become detached from bearers. Look for gaps between piles and bearers and uplifted or damaged timber framing and connections. Check sub-floor braces. Check for liquefaction under a piled house. If not removed, moisture and silt resulting from liquefaction can result in mould, mildew and later health issues for the occupant.

CRACKED FLOOR SLABS AND LATERAL SPREAD

Lateral spread of foundations and significant cracks in floor slabs can be clearly visible. Large cracks can result in steps in floor level and movement along the crack. Small cracks are often not obvious unless carpets are lifted. Look for cracks in wall linings possibly caused by slab movement and for signs of cracks in adjacent uncarpeted rooms such as the garage or bathroom where floor slab cracks can result in split tiles or grout joints. Look for lateral spread of the ground surrounding the building and check for corresponding cracks inside.

LIQUEFACTION AND FRAMING CAVITIES

Cavities are enclosed framing spaces between the exterior cladding, such as brick, and the interior wall lining. A building cavity commonly contains the structural framing, building paper and thermal insulation, as well as electrical and plumbing services. Silt and water entering these cavities can cause rot, damp and mould, with associated possible health issues. Cavities must be checked and if necessary cleaned and dried as part of the repair process (*see also GIB® Information Bulletin 'Assessing Water Damage to Plasterboard Linings').*

WEATHER TIGHTNESS

Post-earthquake damage may have occurred following water ingress, due to the time taken to make the building water-tight. Wet plasterboard ceilings can sag under their own weight and the weight of insulation and fittings. Once dry, the sag becomes permanent. Any ceiling under a damaged roof that is sagging or appears to have drip marks or damp patches must be checked and replaced if necessary. Check insulation to ensure it is dry and replace if necessary.

WALL BRACING

Wall bracing is generally hidden and some strength and stiffness may have been lost. Loss of stiffness can be evident from owner observations of a 'noisier' home. Research by Hunt ("Post Earthquake Performance of Plasterboard Bracing Systems", dated 2011, www.gib.co.nz) confirms this loss of stiffness. Unless bracing stiffness is reinstated it is likely that cosmetic plaster and paint repairs will continue to crack at a level of movement experienced in more frequent future events such as wind gusts, aftershocks or even traffic. If indications point to loss of stiffness then further investigation must be carried out.

WALL BRACING cont…

Consult existing bracing plans and calculations to locate designated bracing elements and check their condition and fixings. If no calculations exist then a suitable bracing system must be determined before remedial work is carried out.

1. Corners and opening

Cracking and distortion of sheet materials often occurs in building corners where walls or walls and ceilings meet, and around corners of doors and windows openings. If cracking has extended diagonally from such a corner into the field of a bracing element, then the sheet must be replaced. For further detail see the repair recommendations.

2. 'Drummy' linings

Wall or ceiling linings that sound hollow when hit with an open palm. If nails, screws or glue has let go in the field of sheets then new screw fixings must be installed.

3. Slotting of wall linings around fasteners

Elongation of the wall lining hole around fasteners can occur following an earthquake. A level of bracing strength is still achieved when the structure moves far enough for the fastener to contact the end of the slot. However, early stiffness is lost resulting in a noisy or 'soft' house.

4. Plaster 'Pops'

If slots are big enough they can affect the surface of the board where compounds have been applied over nail or screw heads resulting in blisters, pops, or small plaster lumps at the fastener location.

5. Frame attachment

Rocking of a structure can compromise bottom plate attachment to the floor and stud-to-plate connections.

Pull carpet up near the wall, and check for gaps using a flexible steel rule or similar

Remove skirting boards in selected bracing element locations and look for signs of movement of the wall lining fasteners. Check also that fasteners have been installed in the correct pattern for a designated bracing element.

Cut a small hole in the wall lining above the bottom plate where a bottom plate and stud hold-down fixing is located at the end of a high performance bracing element such as GIB Braceline®. Check for correct installation of the hold-down fixing and for signs of movement or damage.

For information on repairing gypsum plasterboard walls and ceilings refer to the GIB® information bulletin: *'Guidelines for Repairing GIB® plasterboard linings in wind or Earthquake Damaged Properties'*, at www.gib.co.nz.

LATH AND PLASTER

Lath (or lathe) and plaster wall lining was commonly used in older pre 1960s houses. Laths are long strips of timber around 20 to 25 mm wide, and 6 to 10 mm thick, nailed to the timber framing. A gap is left between each lath so that when cement plaster is applied at around 16 to 18 mm thickness, a percentage flows through the gaps in the lath and forms a 'key'. The wall is then coated with a gypsum plaster to obtain a smooth surface finish that can be papered or painted. When subjected to violent shaking, the cement plaster key can break, resulting in loss of adhesion of the plaster, cracks and chunks falling from walls and ceilings (refer GIB® Information Bulletin 'Repairing Lath and Plaster Walls & Ceilings', at www.gib.co.nz).

DAMAGE ASSESSMENT CHECKLIST

SUGGESTED TOOLBOX

Non-intrusive Checks: Plumb bob and suitable spirit level(s), tape measure and flexible steel rule, torch, builders pencils, step ladder, note pad / iPad
Intrusive Checks: Carpenters hammer, nail punch, battery drill with hole saws, key hole saw, wood chisel, crowbar, pliers, screw drivers, adjustable crescent

Name		**Number of storeys**	
Street & Number		**Foundation Type**	
Lot & DP Number		**Roof type/weight**	
City/Town/District		**Cladding type/weight**	
Assessor		**Notes**	
Company Name			
Date			

Sketch (Building Dimensions)

Building Element	Check for	Tip	Notes
Site	Lateral spread and subsidence Liquefaction Driveway condition Changed levels and falls	Changes in level or lateral spread are likely to have affected the structure. Foundations and levels must be reinstated before structure repairs are carried out.	
Building	Obvious external material damage Level Out of plumb	NZS3604:2011 suggests a maximum deviation from vertical of 5 mm per 2.4 m stud height or 15 mm total for a 2 storey building. The suggested deviation from horizontal is 5 mm over 10 m or 10 mm total for longer lengths. ***Note: These tolerances may be too tight for existing buildings***	
Claddings	Weather tightness		
Subfloor	Water and silt following liquefaction Movement of or cracks in perimeter footings Movement of piles Movement of bearers on piles and fixings Movement of joist on bearers and fixings Bearer connections to perimeter footings	Also check for water and silt in brick veneer cavities possibly entered through weep holes.	
Slab	Level Cracks Vertical or lateral shift Connections to footings	See tolerances above.	
Wall bracing	Location of designated bracing elements Fixing of designated bracing elements Damage to bracing elements	Obtain original bracing plans and calculations if possible. If not available, carry out a bracing evaluation.	
Exterior Walls	Plumb Distortion, cracking around windows, doors Do windows and doors sit square in frames Any gaps at cladding to joinery junctions Liquefaction products in construction cavities Any signs of bottom plate lifting or stud rotation Movement of walls at either end of lintels or beams.	Aluminium joinery can be forced out of square due to racking forces giving the appearance of an out of plumb building. Any silt must be removed and exterior wall cavities and insulation dried before remedial work to wall linings is carried out, see GIB® Bulletin ***'Assessing Water Damage to Plasterboard Linings''*** at www.gib.co.nz Bulging of the internal linings above or near openings can indicate movement of beams or lintels.	

Building Element	Check for	Tip	Notes
Interior Wall Linings	Plumb Cracking around joinery and wall to ceiling joints Cracking of joints or lining sheets Bouncy or 'drummy' linings Blistered paint or 'popped' filler at fastener locations Slotting around lining fasteners Any signs of bottom plate lifting or stud rotation	See '***Guidelines for Repairing GIB® plasterboard linings in wind or earthquake damaged properties'*** at www.gib.co.nz Work from minor cosmetic damage, then check for indications of sheet and lining fastener stress, then remove skirtings to further investigate damage to linings, fasteners and framing connections	
Ceilings	Holes from falling objects Water / weather damage Cracking of joints or lining sheets Bouncy or 'drummy' linings 'Pops' at fastener locations Slotting around lining fasteners	See '***Guidelines for Repairing GIB® plasterboard linings in wind or earthquake damaged properties'*** at www.gib.co.nz	
Lath and Plaster	Fallen sections of plaster Cracking 'Drummy' walls or ceilings Loss of plaster 'key'	See ***'Repairing Lath and Plaster Walls & Ceilings'*** at www.gib.co.nz	
Ceiling void	Water header tank for movement Heavy item strapping Roof void and roof plane braces and connections Roof framing and truss integrity including fixings Tile battens and tile fixings Weather tightness and signs of water marks on ceilings and eaves Insulation placement and condition	Also check for any other water or bulk storage devices and ensure adequate strapping and supports	
Heavy Roofs	Missing or broken tiles Alignment of tiles Weather tightness	Tie loose tiles. Replacing a heavy roof with a lightweight roof can reduce earthquake demand forces by 40%.	
Light Roofs	Fixings Condition of roofing after possible impact Weather tightness		
Chimney	Plumb Cracks in mortar and bricks	Remove or reinforce heavy weight chimneys. Chimney removal will reduce earthquake demand and future risk of collapse.	
Electrical	Any reported electrical faults	Turn of mains power before investigating wall and ceiling cavities.	