Macroseismic Intensity Assessment for the M6.2 2011 Christchurch Earthquake

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EXECUTIVE SUMMARY

We undertake a Modified Mercalli Intensity (MMI) survey of building damage arising from the M6.2 22 February 2011 Christchurch earthquake. The survey is focused close to the strong motion accelerograph stations of Christchurch city in an effort to: (1) capture data describing the highest intensity levels produced by the earthquake, and; (2) further constrain the MMI-Peak Ground Velocity (PGV) Ground Motion Intensity Conversion Equation (GMICE) for New Zealand, which was developed prior to the Christchurch earthquake (Gerstenberger et al. 2007). The inability of the existing New Zealand MMI scale to assign MMI levels based on damage to modern building types and associated vulnerability classes requires us to apply the newly-developed Global Earthquake Model (GEM) International Macroscopic Scale (IMS) to our survey data (globalquakemodel.org).

Our estimates of IMS (referred to as MMI_{IMS} in the report) in the vicinities of the strong motion stations show a range of 8 to 11, with typical values of 9. No clear trend of increasing MMI_{IMS} with PGV is observed in the survey data, but the data clearly show higher MMI_{IMS} values for a given PGV than the MMIs estimated from PGV with the Gerstenberger et al. (2007) GMICE. For the range of PGVs represented in the Christchurch accelerograph data (40-100cm/s) we observe the MMI_{IMS} to be about 1 unit higher than the estimated MMIs from the GMICE. In contrast, the MMI-PGA GMICE of Dowrick and Rhoades (2011) shows good agreement with the MMI_{IMS} survey data due to the lesser amount of saturation of the curve at high PGAs. Future applications of the Gerstenberger et al (2007) GMICE could therefore consider upward adjustment of the estimates of MMI to acknowledge the Christchurch results.

NON-TECHNICAL SUMMARY

We have conducted a survey of damage to 160 buildings from the M6.2 22 February 2011 Christchurch earthquake to estimate earthquake intensities produced by this very significant earthquake. Intensity is the human scale of earthquake shaking based on observations and building damage. The Modified Mercalli (MM) scale is the most commonly used intensity scale, and ranges from 1 to 12. Few intensities of greater than 8 (intensities associated with significant building damage) have been estimated for New Zealand earthquakes, so estimates made from the damaging Christchurch earthquake was seen as an important opportunity. The survey was focused close to seismic stations in the city in order to compare the resulting intensity estimates to the measured shaking levels at the stations (measured in units of acceleration and velocity). Knowing how intensity compares to instrumental measures of shaking like acceleration and velocity (measures of direct relevance to engineering design) allows older historical earthquake intensity estimates to contribute to modern datasets and applications (e.g. earthquake hazard maps). Our intensities are based on a new international intensity scale developed by the Global Earthquake Model (GEM Foundation; globalquakemodel.org). The older New Zealand MM intensity scale was not used as it is limited to damage descriptions of older buildings.

Our intensity estimates in the vicinities of the strong motion stations range from 8 to 11, with typical values of 9. We have compared these intensities to the accelerations and velocities recorded at the seismic stations in the city, and now have a good understanding of how intensity, acceleration and velocity compared during this major earthquake.

1.0 INTRODUCTION

This report documents a study that has been carried out for the Earthquake Commission Research Foundation (EQC). The study is focused on providing estimates of macroseismic intensity for the M6.2, 22 February 2011 Christchurch earthquake by way of a traditional macroseismic intensity survey (e.g. Dewey et al. 1995, 2002) in order to provide additional data to constrain one of the recent Ground Motion Intensity Conversion Equations (GMICE) for New Zealand (Gerstenberger et al. 2007). A GMICE provides the ability to convert between estimated earthquake intensity (e.g. Modified Mercalli Intensity, MMI) and instrumental measures of ground motion (e.g. peak ground acceleration and velocity; PGA and PGV), so can be used to augment instrumental datasets with intensity-based acceleration estimates. Near real-time applications such as ShakeMap (earthquake.usgs.gov/earthquakes/shakemap/) rely on GMICEs to provide estimates of MMI from PGA and PGV (instrumentally-based MMI). The focus of our study is to provide estimates of the highest levels of MMI produced during the Christchurch earthquake, given that the Gerstenberger et al. GMICE is not well constrained by data at the highest levels of MMI. This is due to the limited number of observations of MM>8 for historical New Zealand earthquakes, and the fact that GeoNet's online felt reports do not distinguish between MMIs greater than 8 (i.e. MM8 is the maximum assigned). The Christchurch earthquake clearly produced very strong ground motions (peak ground accelerations, PGAs >1g), so MMIs greater than 8 are expected to have been experienced during the earthquake.

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2.0 METHOD

2.1 GENERAL APPROACH

Our general approach is to collect building damage data near strong motion accelerograph stations (generally within 2km of the stations) for the M6.2 22 February 2011 Christchurch earthquake, and use these data to develop estimates of MMI. Collecting data near strong motion stations is consistent with the Gerstenberger et al (2007) approach, but in this study the MMI data are collected by way of traditional MMI survey. Our explanation and specific application of traditional MMI assessment is described in the next section.

2.2 MMI SURVEY

We conduct a traditional MMI assessment, which uses eye witness accounts and observations of building damage to estimate MMI levels for the causative earthquake (e.g. Dewey et al. 1995, 2002). In order to conduct a traditional MMI assessment for the Christchurch earthquake we first develop a survey questionnaire to use in a foot survey of residential and commercial buildings mostly located within about 2km of the various strong motion accelerograph stations in the city. The survey questionnaire is developed from the GeoNet felt reports (geonet.org.nz) and is shown in Appendix 1. A total of 18 Christchurch strong motion stations are focused on in our study, and these are listed with the PGAs and PGVs recorded during the Christchurch earthquake in Table 2.1. The survey questionnaire includes questions on personal experiences during the earthquake effects, and questions that require our own observations of the buildings. Care is taken to ensure that survey responses are specific to the Christchurch earthquake, and that none of the observed building damage or personal experiences can be attributed to liquefaction. From the survey questionnaire, pertinent information is used to develop building type and damage grade information.

In all, we visited 160 residential and commercial buildings in the city over a two week period in February 2013. Buildings were surveyed by pairs of team members, and the total team (other than the authors) is listed in the Acknowledgements. Processing of the survey data from questionnaire to spreadsheet, and assignment of latitude and longitude coordinates to the buildings have been carried out at GNS Science.

The locations of the strong motion stations and building locations are shown in Figure 2.1, and the buildings are shown by the coloured symbols in the Figure. The symbols and colours distinguish the various building types, and these can be related to equivalent vulnerability classes in Appendix 2. Appendix 2 uses the A to E vulnerability classes of the International Macroseismic Scale (IMS) of the Global Earthquake Model (GEM; globalquakemodel.org; Foulser-Piggott and Spence, 2013, Spence et al., 2014). Our justification for using the IMS is that the vulnerability classes and associated damage grades (degree of damage descriptors; Appendix 3) cover a much wider spectrum of building types than the New Zealand MMI scale, and an update of the latter is unavailable at the present time.

Table 2.1 Strong motion accelerograph stations used in our study, and the PGAs and PGVs recorded during the M6.2 22 February 2011 Christchurch earthquake.

Station ID	Station Location	Latitude	Longitude	PGA(g)	PGV(cm/s)
CBGS	Chch Botanic Gardens	43.5293	172.6199	0.517	57.1
CCCC	Chch Cathedral College	43.5395	172.6464	0.473	68.1
CHHC	Chch Hospital	43.5355	172.6261	0.328	57.4
CMHS	Cashmere High School	43.5656	172.6242	0.345	40.7
HPSC	Hulverstone Pumping Station	43.5032	172.7021	0.143	26.9
HVSC	Heathcote Valley School	43.5901	172.7156	1.43	97.7
LPCC	Lyttelton Port	43.6056	172.7223	0.766	38.7
NNBS	Nth New Brighton School	43.4954	172.718	0.752	76.1
PPHS	Papanui High School	43.4928	172.6069	0.208	37.4
PRPC	Pages Rd Pumping Station	43.527	172.7017	0.652	96.1
REHS	Resthaven	43.522	172.6352	0.705	85.2
RHSC	Riccarton High School	43.5398	172.5739	0.284	33.9
SHLC	Shirley Library	43.507	172.6633	0.303	74.9
SMTC	Styx Mill Transfer Station	43.4692	172.6137	0.177	34.5

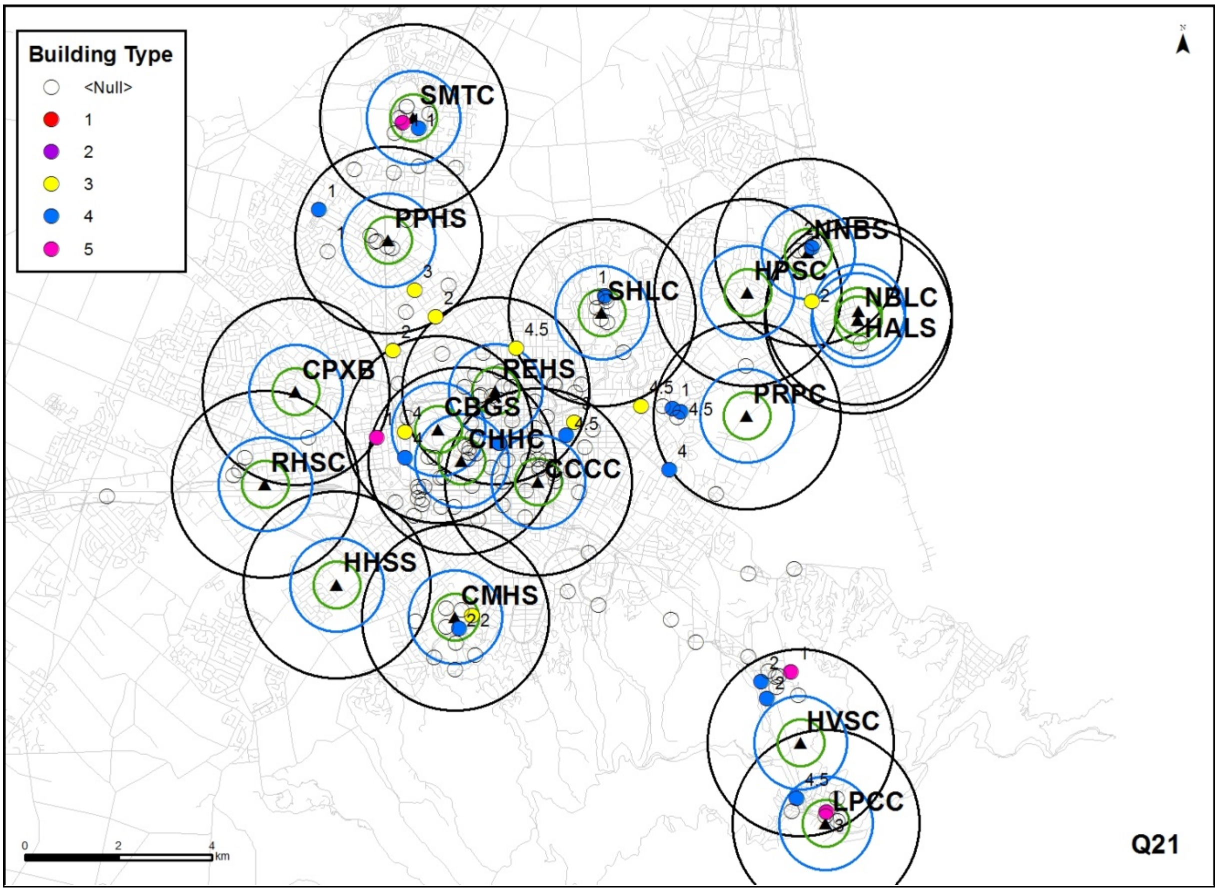


Figure 2.1a Location of strong motion accelerograph stations in Christchurch city (black solid triangles with the station code labelled with bold capitals, e.g. **CMHS**), circles marking distances of 500m (green), 1km (blue), and 2km (black) from the stations, and the buildings visited in our survey (coloured dots). The building types are signified by colours (see Legend and Appendix 2 for building type and corresponding vulnerability class). Damage grades are the numerical values next to the building locations, and are based on Appendix 3 and responses to Question 21 in the Questionnaire (see Q21 label at lower right of the map). See Appendix 1 for the Questionnaire, Appendices 2 and 3 for the description of building types and damage grade, and Appendix 4 for the damage grade assignments derived from responses to Question 21.

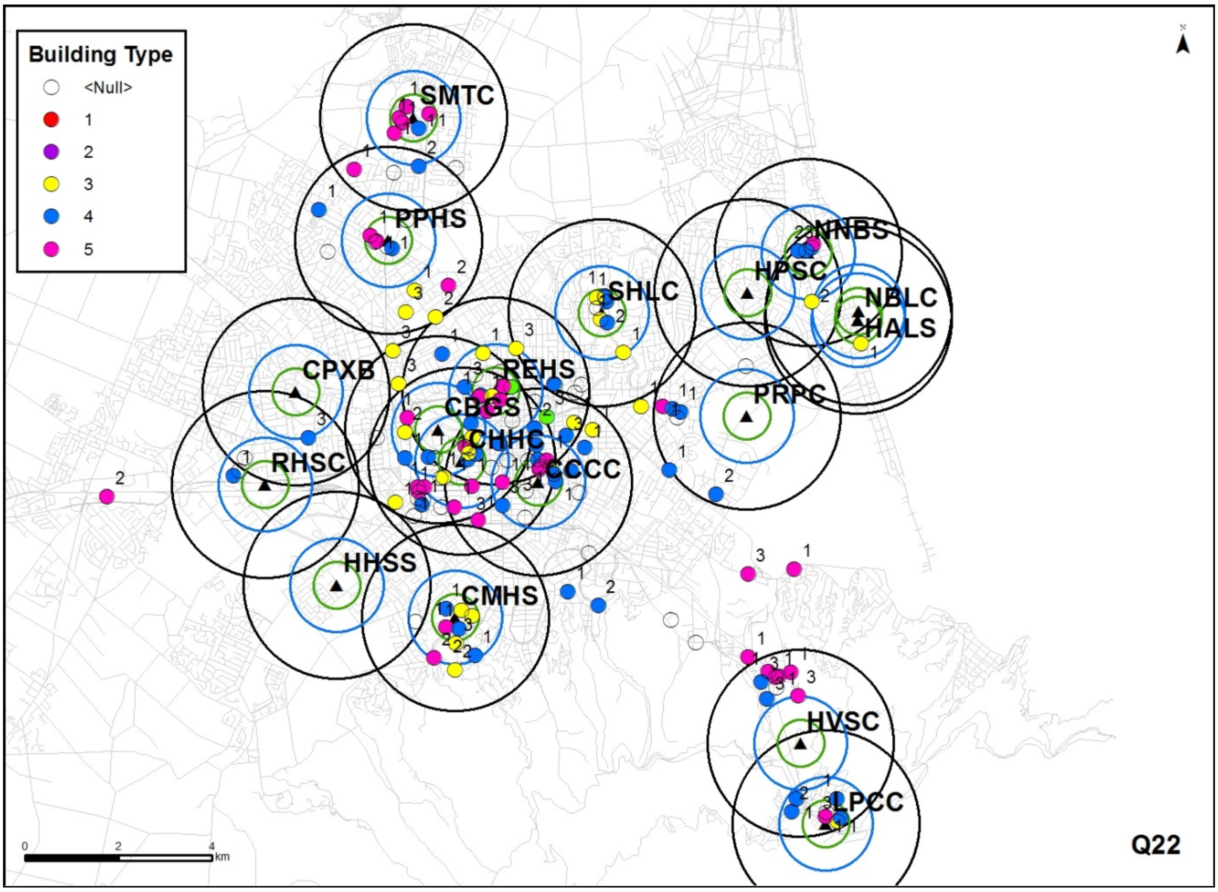


Figure 2.1b As for Figure 2.1a except the damage grade assignments are based on responses to Question 22 in the Questionnaire (see Q22 label at lower right of the map). See Appendix 1 for the Questionnaire, Appendices 2 and 3 for the description of building types and damage grade, and Appendix 4 for the damage grade assignments derived from responses to Question 22.

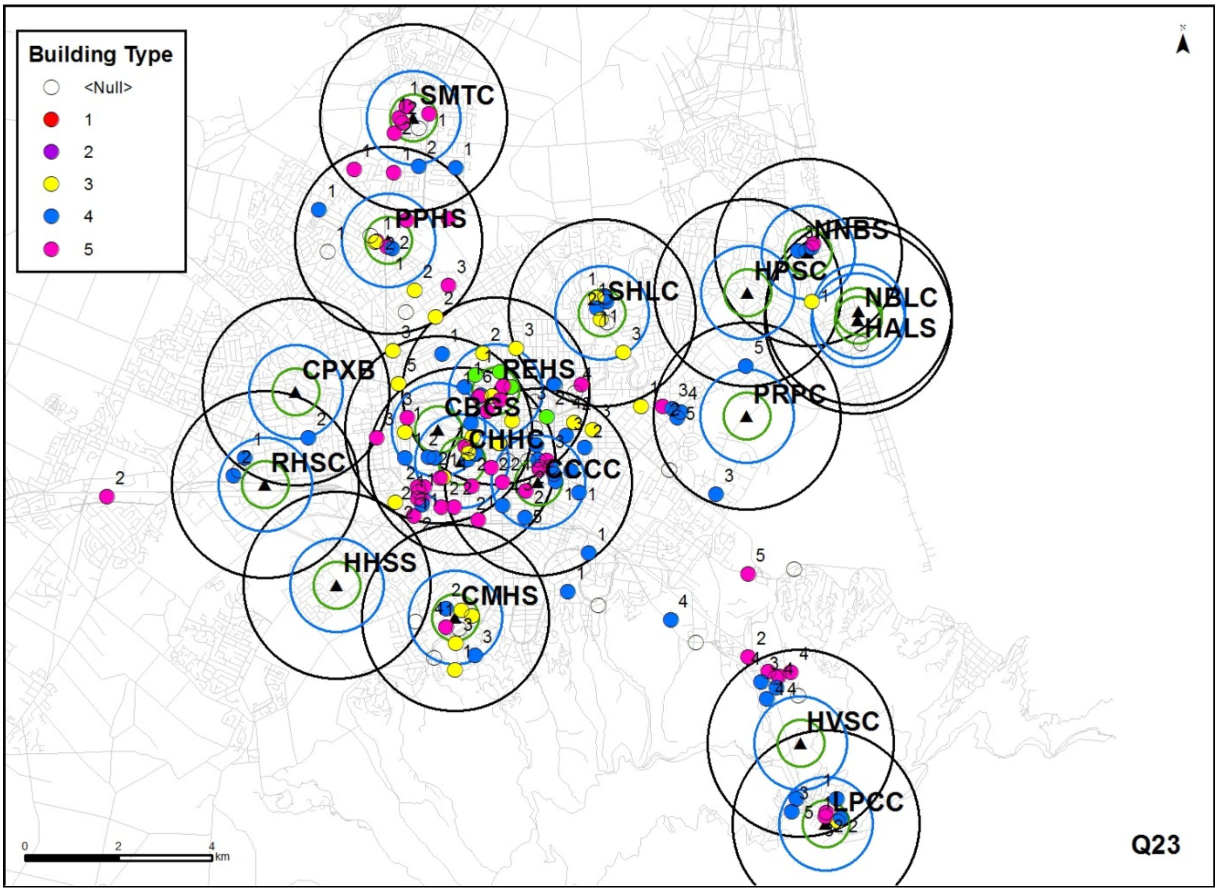


Figure 2.1c As for Figure 2.1b except the damage grade assignments are based on responses to Question 23 in the Questionnaire (see Q23 label at lower right of the map). See Appendix 1 for the Questionnaire, Appendices 2 and 3 for the description of building types and damage grade, and Appendix 4 for the damage grade assignments derived from responses to Question 23.

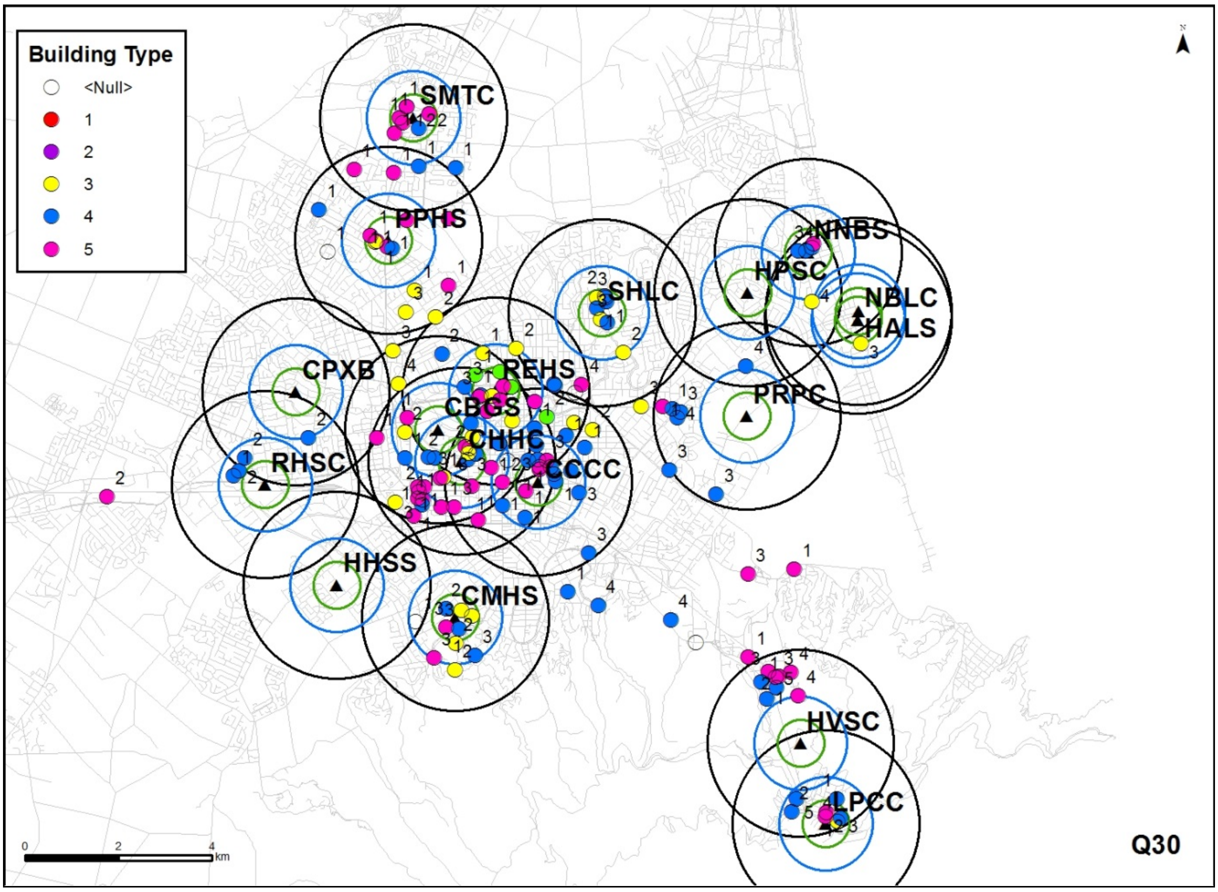


Figure 2.1d As for Figure 2.1c except the damage grade assignments are based on responses to Question 30 in the Questionnaire (see Q30 label at lower right of the map). See Appendix 1 for the Questionnaire, Appendices 2 and 3 for the description of building types and damage grade, and Appendix 4 for the damage grade assignments derived from responses to Question 30.

3.0 ANALYSIS

3.1 MMI ASSIGNMENT

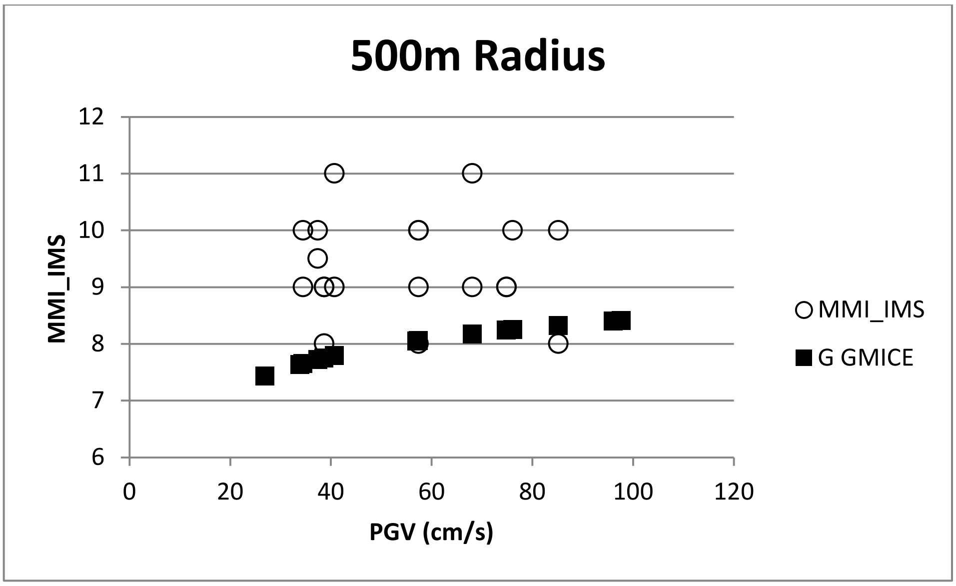
We follow the procedure developed by Grunthal (1998) and updated by Spence et al. (2014) for assignment of IMS-based MMI (hereafter referred to as MMI_{IMS}) to our combinations of building type and damage grade (Appendices 2 to 5). Multiple observations of damage grades for a given building type are required in order to apply the “few, many, most” categories and assign MMI_{IMS} (Appendix 5). Appendix 6 shows tables that provide counts of damage grades for building types within 500m, 1km and 2km of the strong motion accelerograph stations in Figure 2.1. We show four Tables for each strong motion station and distance category, as separate counts of building type and damage grade are given for each of Questions 21, 22, 23 and 30 of the Questionnaire (Appendix 1). Responses to these questions provide critical information regarding damage grade. Correspondingly, four estimates of MMI_{IMS} are shown at the base of each set of four Tables, along with the average MMI_{IMS} estimate from the four Tables.

Appendix 6 shows that the MMI_{IMS} assignments for a given strong motion station range from 8 to 11, with 9 being the most commonly assigned MMI_{IMS}. The range of MMI_{IMS} can therefore be assumed to represent an uncertainty of approximately $\pm$1 to 2 MMI_{IMS} units.

3.2 MMI VERSUS PGV VERSUS GMICE

In Figure 3.1 we compare the estimates of MMI_{IMS} derived from our traditional assessment plotted according to PGVs measured at the various strong motion accelerograph stations. The two graphs show the results for the 500m and 2km search radii. The MMI_{IMS} values are plotted as open circles on each graph, and are taken from the values labelled “MMI” at the base of each Table in Appendix 6. The solid squares represent the MMI-PGV relationship of Gerstenberger et al (2007). Two main observations can be made from the graphs. First is the wide scatter of data, with no apparent trend of increasing MMI_{IMS} with PGV. The range of MMI_{IMS} for a given PGV is ca. 2, and the range of PGV for a given MMI_{IMS} is a factor of 2 to 3 of the PGV. The second observation is that the data plot above the Gerstenberger et al. (2007) GMICE curve almost without exception. This can be interpreted as the Christchurch earthquake having produced much higher intensities than would have otherwise been estimated from PGV with the GMICE.

Since a MMI-PGA relationship is not available from the Gerstenberger et al. (2007) study, we instead compare the measured PGAs at the strong motion stations to the Dowrick and Rhoades (2011) GMICE in Figure 3.2. As seen for MMI_{IMS}-PGV, a similarly wide scatter and lack of trend is observed between MMI_{IMS} and PGA in Figure 3.2. However, the data plot more evenly about the Dowrick and Rhoades (2011) GMICE curve than in the case of the Gerstenberger et al. (2007) GMICE. The reduced degree of saturation of the Dowrick and Rhoades (2011) GMICE curve at the high PGAs cf the PGV saturation of the Gerstenberger et al (2007) curve is the obvious reason for the differences.



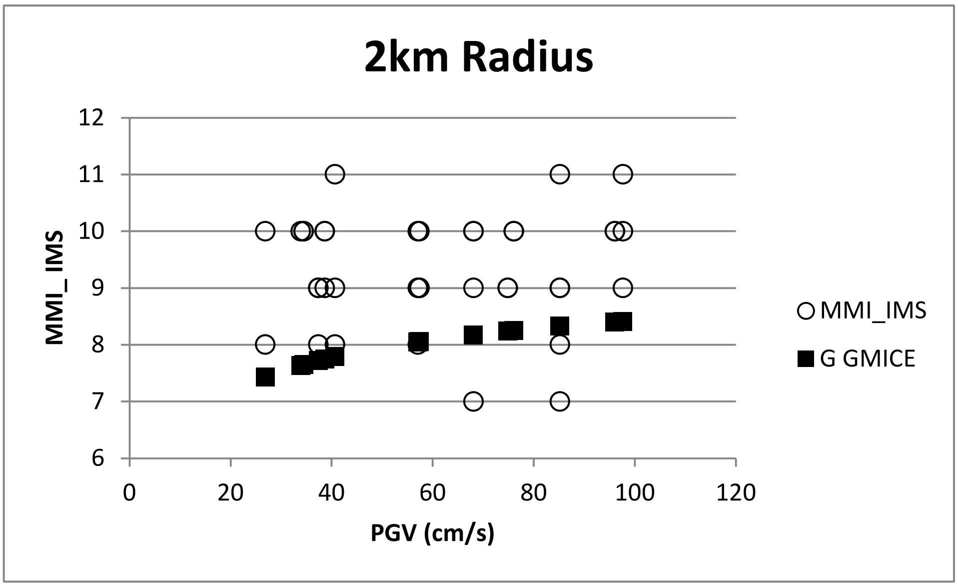
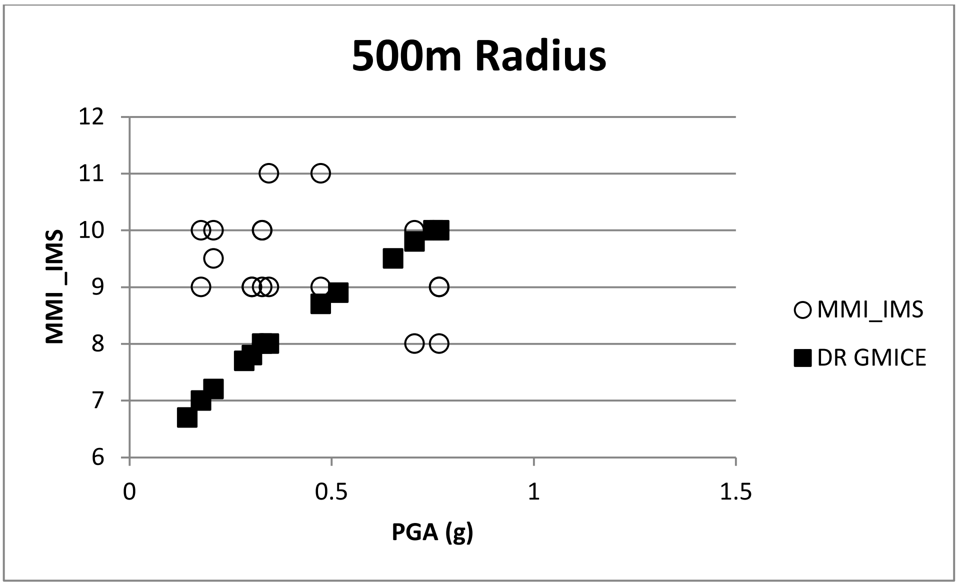


Figure 3.1 Graphs of MMI_{IMS} on PGV for 500m and 2km search radii. The survey data are represented by the open circles (MMI values at the base of each Table in Appendix 6), and the Gerstenberger et al. (2007) GMICE by the solid squares (labelled “G GMICE”). See the text for further explanation.



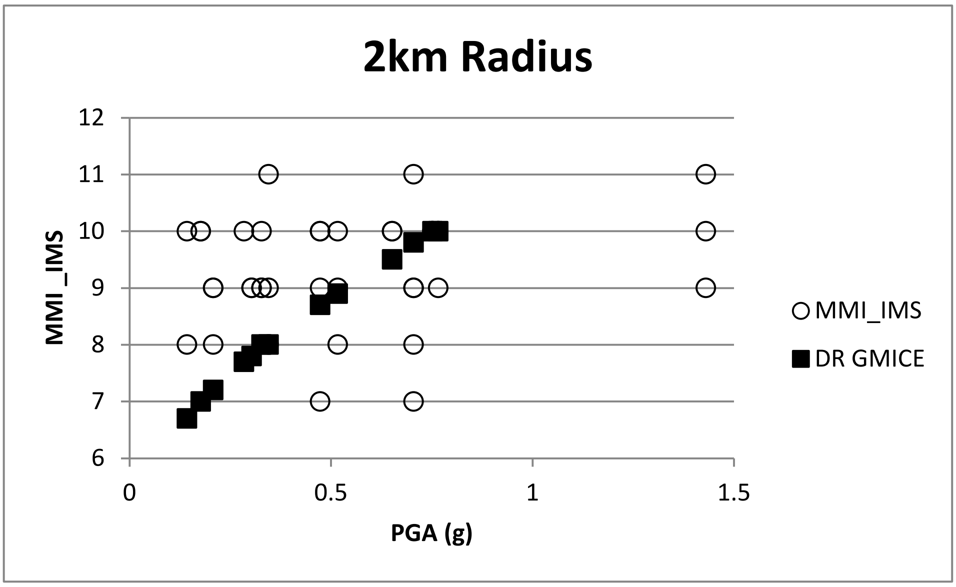


Figure 3.2 Graphs of MMI_{IMS} on PGA for 500m and 2km search radii. The survey data are represented by the open circles (MMI values at the base of each Table in Appendix 6), and the Dowrick and Rhoades (2011) GMICE by the solid squares (labelled "DR GMICE"). See the text for further explanation

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4.0 DISCUSSION AND CONCLUSIONS

We have undertaken a traditional MMI survey of building damage arising from the M6.2 22 February 2011 Christchurch earthquake. The survey was focused close to the strong motion accelerograph stations of Christchurch city in an effort to: (1) capture data describing the highest intensity levels produced by the earthquake, and; (2) further constrain the MMI-PGV GMICE for New Zealand, which was developed prior to the Christchurch earthquake (Gerstenberger et al. 2007). Limitations of the existing New Zealand MMI scale with respect to addressing the more modern building types and associated vulnerability classes required us to apply the newly-developed GEM IMS to our survey data.

The resulting estimates of MMI_{IMS} in the vicinities of the strong motion stations show a range of 8 to 11, with typical values of 9. No clear trend of increasing MMI_{IMS} with PGV is observed in the survey data, but the data clearly show higher MMI_{IMS} values for a given PGV than the MMIs estimated from PGV with the Gerstenberger et al (2007) GMICE. For the range of PGVs represented in the Christchurch accelerograph data (40-100cm/s) we observe the MMI_{IMS} to be about 1 unit higher than the estimated MMIs from the GMICE. Future applications of the Gerstenberger et al. (2007) GMICE should consider upward adjustment of the estimates of MMI to acknowledge these Christchurch results, as the strong saturation of the GMICE curve at high PGVs does not match the Christchurch results. In contrast, the MMI-PGA GMICE of Dowrick and Rhoades (2011) shows good agreement with the MMI_{IMS} survey data due to the lesser amount of saturation of the curve at high PGAs.

As a final note, it is important to acknowledge the considerable unforeseen difficulties encountered during the course of this study. After the survey had been conducted, we soon realised that the New Zealand MMI scale would be inadequate for assigning MMIs to our survey data at the higher levels of MMI (>8). This is because the New Zealand MMI scale does not adequately represent the modern building types of New Zealand with respect to these higher levels of MMI. While an effort to modernise the New Zealand scale was initiated by a group of New Zealand engineers in 2013, it was acknowledged that this task would be far too large to fit into the timelines of our project. The timely availability of the GEM IMS and ability to apply it to New Zealand damage data has therefore been fortuitous, even if our timeline for project completion had to be delayed significantly in order to navigate this alternative work path. Consequently, these delays have prevented our update of the Gerstenberger et al (2007) GMICE. Instead, the study provides insight into the behaviour of the Gerstenberger et al (2007) GMICE at high levels of PGV, and also shows that the Dowrick and Rhoades (2011) GMICE provides a reasonable match to the Christchurch observations at high levels of PGA and MMI.

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5.0 ACKNOWLEDGEMENTS

EQC is gratefully acknowledged for funding this study, and for allowing a no-cost time extension to the study when we encountered unanticipated difficulties in applying the New Zealand MMI scale to our survey data. Richard Smith in particular is thanked for his role in granting the no-cost extension. Aggeliki Barberopoulou, Hannah Mirabueno, Karine Tan, and Kim Wright, are all thanked for their hard work during the February 2013 survey. Maureen Coomer is thanked for her considerable efforts with processing the survey responses into a workable spreadsheet, and Biljana Lukovic is thanked for assigning latitudes and longitudes to the surveyed buildings. Andrew King is thanked for his assistance in assigning building types to the surveyed buildings, and Roxanne Foulser-Piggott is thanked for assistance with explaining the IMS, and for supplying relevant literature. David Rhoades and Albert Zondervan are thanked for their peer reviews of the report. Finally, a special thanks goes to the people of Christchurch who willingly took part in our survey, and candidly recounted the impacts of the 22 February 2011 earthquake.

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APPENDICES

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APPENDIX 1: SURVEY QUESTIONNAIRE

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GNS Science. 1, Fairway Drive. Avalon. Lower Hutt 5010. PO Box 30368.
Phone 04-5701444

MACROSEISMIC QUESTIONNAIRE CHRISTCHURCH FEBRUARY 2013

REFERENCE:________________________ Pictures reference:________________
Date of earthquake: 22nd FEBRUARY 2011 Time of earthquake: 12:51PM (NZ time)
Date interviewed:________________ Interviewed by: ______________________

Name:________________________ Age : ________ Gender : ______________
Street/Road No.: ________________Street address: ______________________
Suburb: _______________________ City: Christchurch
Email address (if available): ____

0. Did you feel the earthquake? ☐ Yes ☐ No

1. Where you at this address when the earthquake occurred? ☐ Yes ☐ No

If not, is there anyone in the house who has here on that day? ☐ Yes ☐ No
(NOTE: do not proceed with the survey if both answers are NO)

2. If yes, where were you at the time of the earthquake?
☐ Indoors ☐ Outdoors ☐ In a stopped vehicle ☐ In a moving vehicle

3. What were you doing when the earthquake occurred?
☐ Sitting/lying ☐ Standing ☐ Walking/Running ☐ Sleeping ☐ Travelling in a vehicle

4. How strong was the earthquake shaking that you felt?
☐ Not felt (even if heard) ☐ Weak shaking (hardly recognised as an earthquake)
☐ Mild shaking (or a jolt) ☐ Moderate shaking ☐ Strong shaking ☐ Violent shaking

5. Was it difficult to walk steadily or to stand?
☐ Yes, difficulty in walking steadily ☐ Yes, difficulty in standing
☐ No, no difficulty in walking steadily or standing ☐ Don't know / Not applicable

6a. What was your reaction?
☐ No reaction / Not felt ☐ Very little reaction ☐ Excited but not alarmed ☐ A bit frightened
☐ Very frightened ☐ Extremely frightened / Panic ☐ Don't know / Not applicable

6b. What was your first response *while* the earthquake was shaking?
☐ Continued what I was doing before ☐ Stopped what I was doing but stayed where I was
☐ Dropped, covered under a sturdy piece of furniture (e.g., table or desk), and held on to it
☐ Tried to protect other people nearby ☐ Tried to protect property nearby (e.g., prevent things from falling) ☐ Immediately left the building I was in ☐ Continued driving
☐ Pulled over to the side of the road ☐ Other (please explain) __________________________

6c. Did you evacuate (leave your home for at least one night) for any reason following the earthquake?

a ☐ Yes (if yes how many nights/weeks) ______________________ ☐ No
b Main reason/s for evacuation/ staying (do not prompt , tick all that apply)
☐ My house was so damaged I couldn't stay in it
☐ Essential utilities weren't functioning (e.g. electricity/water/sewage)
☐ I didn't think my house was safe (could be further damage due to aftershocks)
☐ I didn't want to be alone/ I wanted to be with family/friends
☐ Local schools/businesses/my work were closed so I had to relocate
☐ I wanted to protect family members ☐ My neighbourhood was not pleasant/safe to be in anymore
☐ I couldn't afford to go anywhere else ☐ I had nowhere to go/didn't know where to go
☐ I wanted to stay and protect my property ☐ Other (please explain) ______________________

7. To what extent did you believe each of the following *during* the earthquake shaking?

	Not at all	Small extent	Moderate extent	Great extent	Very great extent
a. your home would be severely damaged or destroyed?	☐	☐	☐	☐	☐
b. you and your family would be injured or killed?	☐	☐	☐	☐	☐

8. Where you were at the time of the earthquake, did anyone run outdoors in fright?
☐ No one ☐ 1 or 2 ☐ Few ☐ Many ☐ Most ☐ Everyone ☐ Don't know/Not applicable

9. Please select the type of building or structure:
☐ Family home or flat ☐ Multi-storey building
☐ Low-rise buildings (eg. offices, supermarket, church, theatre or warehouse)

10. If you were in a multi-storey building, what is the total number of storeys? (Write down number)

11. If you were in a multi-storey building, what floor were you on? (Write down number)

12. Did hanging objects sway? ☐ No ☐ Yes ☐ Don't know / Not applicable

13. Did doors and/or windows rattle?
☐ No ☐ Rattled slightly ☐ Rattled loudly ☐ Don't know/Not applicable

14. Did objects such as glasses, dishes, ornaments or other small shelf items rattle, topple over or fall off shelves?
☐ No ☐ Rattled slightly ☐ Rattled loudly ☐ A few toppled/fell off ☐ Many toppled/fell off
☐ No shelves with unrestrained objects ☐ Don't know/Not applicable

15. Were cupboard or appliance doors thrown open?

☐ No ☐ Yes ☐ Yes, and contents were ejected ☐ Don't know/Not applicable

16. Did any small items of furniture, appliances (such as TV, computer, microwave) or light machinery slide (not just sway) or topple over?

☐ No ☐ Yes, slid a little (less than 5 cm) ☐ Yes, slid a lot (more than 5 cm) or toppled over

☐ Don't know/Not applicable

17. Did any large fixtures, appliances (such as fridge, stove or filing cabinet) or heavy machinery slide (not just sway) or topple over?

☐ No ☐ Yes, slid a little (less than 5 cm) ☐ Yes, slid a lot (more than 5 cm) ☐ Yes, toppled over

☐ Don't know/Not applicable

18. What other effects were caused to objects? Check all that apply, if any:

☐ Filing cabinets or "easy glide" drawers opened (or shut) ☐ Open doors swung

☐ Glassware and/or crockery broken ☐ Windows cracked ☐ Earthenware toilet fixtures cracked

☐ Pendulum clocks stopped, started or changed rate ☐ Hanging pictures knocked against the wall

☐ Hanging pictures fell from the wall

19. Check which services failed, if any:

☐ Water ☐ Electricity ☐ Gas ☐ Telephone ☐ Sewerage ☐ Elevators ☐ Sprinklers ☐ Internet

20. Choose the most severe damage that occurred to brick/concrete chimneys:

☐ No damage ☐ Horizontally cracked or loose bricks dislodged ☐ Twisted or broken at roofline

☐ Fallen from roofline ☐ Fallen from base ☐ Don't know/Not applicable

21. The brick/concrete chimney is...

☐ An old chimney (that is, not reinforced) ☐ A modern chimney ☐ Don't know/Not applicable

22. What other damage occurred? Check all that apply, if any:

☐ Some domestic wood-framed windows cracked ☐ Some glass fallen out of domestic wood-framed windows ☐ Some domestic aluminium-framed windows cracked ☐ Some glass fallen out of domestic aluminium-framed windows

☐ Hairline cracks in interior walls ☐ Cracks around window/door openings in interior walls

☐ Major cracks in interior walls ☐ Suspended ceilings damaged

☐ Roof tiles dislodged ☐ Roof tiles fallen

23. Choose the most severe damage that occurred to exterior walls:

☐ No damage ☐ Hairline cracks ☐ Wide cracks ☐ Segments of walls bulged, distorted or partially collapsed ☐ Some walls totally collapsed ☐ Don't know/Not applicable

24. Choose the main building material for the exterior walls that experienced the damage:

☐ Wood ☐ Stucco (cement) ☐ Brick/stone veneer ☐ Solid brick ☐ Sheet material (fibre cement board, plywood) ☐ Concrete block ☐ Don't know/Not applicable ☐ Other:

25. What damage occurred to the entire building?

☐ Unaffected ☐ Slightly distorted ☐ Severely distorted ☐ Don't know/Not applicable

26. Choose the structural style of the building foundations:

☐ Unbraced piles ☐ Braced piles ☐ Perimeter only concrete ☐ Concrete slab on ground

☐ Raised concrete slab ☐ Pole house ☐ Don't know/Not applicable ☐ Other:

27. When was the building constructed?

☐ Before 1940 ☐ Between 1940 and 1960 ☐ Between 1960 and 1980 ☐ Between 1980 and 1990

☐ After 1990 ☐ Don't know/Not applicable

28. How many chimneys were damaged or fell?

☐ None ☐ A few ☐ Many ☐ Most ☐ Don't know / Not applicable

29. Did any of the following effects occur? Check all that apply, if any (more than one answer is possible):

Were there liquefaction effects within 25m of the place where you were on that day? ☐ Yes ☐ No

Were you affected by landslides above or below your property? ☐ Yes ☐ No

If yes, how far away was the landslide? (Give distance) ______________________

30. Final comments

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APPENDIX 2: BUILDING TYPE DESCRIPTIONS AND CORRESPONDING IMS VULNERABILITY CLASS

The vulnerability class is used with damage grade (Appendix 3) and the IMS to define MMI.

Building Type (Fig 2.1)	Description	Materials	Year	Quality	IMS Vulnerability Class	IMS Description
Buildings Type I	Buildings with low standard of workmanship, poor mortar, or constructed of weak materials like mud brick or rammed earth. Soft storey structures (e.g. shops) made of masonry, weak reinforced concrete, or composite materials (e.g. some walls timber, some brick) not well tied together. Masonry buildings otherwise conforming to Buildings Types I-III, but also having heavy un-reinforced masonry towers. (Buildings constructed entirely of timber must be of extremely low quality to be Type I)	Brick, Masonry, Concrete	pre-1940	Poor, Deficient, Substandard	A	rubble_stone, adobe_(earth_brick)
Buildings Type II	Buildings of ordinary workmanship, with mortar of average quality. No extreme weaknesses, such as inadequate bonding of the corners, but neither designed nor reinforced to resist lateral forces. Such buildings not having heavy un-reinforced masonry towers	Brick, Masonry, Concrete	pre-1940	Sound	B	simple_stone, unreinf_w_manufactured stone_units,
Buildings Type III	Reinforced masonry or concrete buildings of good workmanship and with sound mortar, but not formally designed to resist earthquake forces. Wood framed - cut-in diagonal timber braces both light and heavy cladding - low-rise	Masonry, Concrete	pre-1940	Sound	C	frame_without_ERD, walls_without_ERD
		Wood Frame	pre-1940	Sound	C	WoodFrame_without_ERD, walls_without_ERD
Structures Type IV	Buildings and bridges designed and built to resist earthquakes to normal use standards, i.e. no special collapse or damage limiting measures taken (mid-1930's to c. 1970 for concrete and to c.1980 other materials)	Concrete	1940 to 1969	Implicitly Sound	D	frame_with_moderate_ERD, walls_with_moderate_ERD
		Steel	1940 to 1979	Implicitly Sound	E	steel_structures
		Timber	1940 to 1979	Implicitly Sound	E	Wood_framed_Non-engineered
Structures Type V	Buildings and bridges designed and built to normal use standards, i.e. no special damage limiting measures taken, other than code requirements, dating from since c. 1970 for concrete and c.1980 other materials	Concrete	1970 to 2004	Implicitly Sound	E	frame_w_high_level_ERD, walls_w_high_level_ERD
		Steel	1980 to 2004	Implicitly Sound	E	steel_structures
		Timber	1980 to 2004	Implicitly Sound	E	Wood_framed_Engineered
Structures Type VI	Structures designed and built to normal use standards, i.e. no special damage limiting measures taken, other than code requirements, dating from 2004	All	2004 onwards	Implicitly Sound	F	none_defined
	Structures, dating from c. 1980, with well-defined foundation behaviour, which have been specially designed for minimal damage, e.g. seismically isolated emergency facilities, some structures with dangerous or high contents, or new generation low-damage structures	Concrete, steel	1980 onwards	Implicitly Sound	F	none_defined

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APPENDIX 3: IMS DAMAGE GRADE DESCRIPTIONS FOR BUILDING TYPES THAT ENCOMPASS THE RANGE OF VULNERABILITY CLASSES LISTED IN APPENDIX 2

Note that the masonry building damage classification is unchanged from that of EMS-98 (source: Grunthal, 1998), but reinforced concrete, steel frame and timber frame damage classifications have been updated or included for the first time in the development of the IMS (source: Spence et al., 2014).

Classification of damage to masonry buildings	
	**Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)** Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
	**Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)** Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Serious failure of walls; partial structural failure of roofs and floors.
	**Grade 5: Destruction (very heavy structural damage)** Total or near total collapse.

Table 5 EMS-98 damage grade diagnostics and proposed variants for reinforced concrete structures

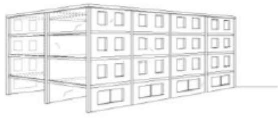
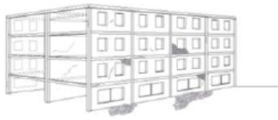
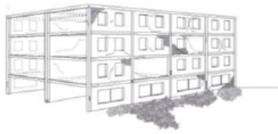
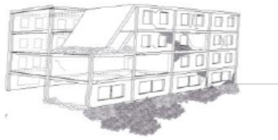
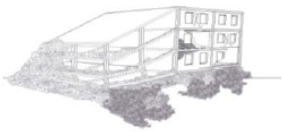
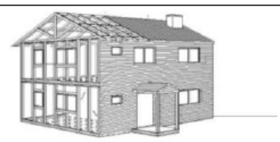
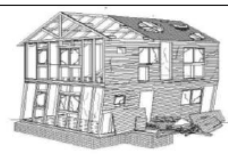
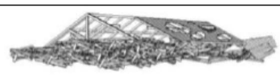
	EMS-98 Definition	EMS-98 Elaboration	Proposed extension	Diagrams
Grade 1	Negligible to slight damage (no structural damage, slight non-structural damage	Fine cracks in plaster over frame members or at the base. Fine cracks in partitions and infills		
Grade 2	Moderate damage (slight structural damage, moderate non-structural damage	Cracks in columns and beams of frames and in structural walls. Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels	Cracks in columns and beams of frames and on shear wall surfaces. (Shear wall structures)	
Grade 3	Substantial to heavy damage (moderate structural damage, heavy non-structural damage	Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of concrete cover, buckling of reinforced rods. Large cracks in partition and infill walls, failure of individual infill panels.	Distress or movement at connections of precast frame connections. Cracks may appear at tops of walls near panel intersections (Precast concrete structures)	
Grade 4	Very heavy damage (heavy structural damage, very heavy non-structural damage)	Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns. Collapse of a few columns or of a single upper floor.	Most concrete shear walls have large, through-the-wall diagonal cracks. Most infill walls exhibit large cracks with bricks that have been dislodged or have fallen.(Shear wall structures) Some critical precast frame connections may have failed (precast concrete structures).	
Grade 5	Destruction (very heavy structural damage)	Collapse of ground floor or parts (e.g. wings) of buildings.		

Table 6. Proposed IMS-14 damage grade diagnostics and proposed variants for steel frame structures

	EMS-98 Definition	Proposed IMS-14 Elaboration	Proposed modifications for sub-classes	Diagrams
Grade 1	Negligible to slight damage (no structural damage, slight non-structural damage	Fine cracks in plaster over frame members or at the base. Fine cracks in partitions and infills		
Grade 2	Moderate damage (slight structural damage, moderate non-structural damage	Few cases of failure or distress of frame members, bracing members or structural connections in a few cases; Cracks in partition and infill walls; failure of brittle cladding and plaster	In light steel frame structures a few rod braces may have yielded. (Light-steel frame structures)	
Grade 3	Substantial to heavy damage (moderate structural damage, heavy non-structural damage	Visible leaning of building or individual storey; some broken or buckled members in roof trusses; some distortion of columns or damage at connections; failure of some bracing members; Large cracks in partition and infill walls, failure of individual infill panels	Many braces have yielded (Light-steel frame structures). Masonry infilled frames may exhibit crushing of masonry around beam-column connections.(Masonry infilled frame structures)	
Grade 4	Very heavy damage (heavy structural damage, very heavy non-structural damage)	Building or individual storey leaning heavily; many failed members and/or connections ; roof members shifting on column support; major distortion of columns.	Most infill walls exhibit large cracks. Masonry infill may bulge out-of-plane and some masonry may be dislodged and fall (Masonry infilled frames)	
Grade 5	Destruction (very heavy structural damage)	Collapse or partial collapse of entire structure Large permanent lateral displacement		

Table 7. Proposed IMS-14 damage grade diagnostics and proposed variants for timber frame structures

	EMS-98 Definition	Proposed IMS-14 Elaboration (for lightweight timber structures)	Proposed modifications for subclasses	Diagrams
Grade 1	Negligible to slight damage (no structural damage, slight non-structural damage	No damage to structural frame. Few hairline cracks in internal walls or brick. Fall of small pieces of plaster.		
Grade 2	Moderate damage (slight structural damage, moderate non-structural damage	Little or no damage to structural frame. Small cracks in plaster or plasterboard edges; cracks in brick veneers; ; cracks of some masonry chimneys.		
Grade 3	Substantial to heavy damage (moderate structural damage, heavy non-structural damage	Some frame distortion visible. Veneers fail and expose frame. Large cracks in plaster or plasterboard edges. Roof tiles detach. Some chimneys fracture at roof line. Failure of individual non-structural elements (partitions, gable walls). Some shifting of unsecured foundations.	Small cracks or wood splitting at bolted connections (heavy timber frame structures).	
Grade 4	Very heavy damage (heavy structural damage, very heavy non-structural damage)	Serious frame distortion. Total failure of brick veneers. Toppling of most masonry chimneys. Houses not secured to foundations shifted off. Failure of some cripple walls	Partial collapse of soft-storey configurations (soft-storey structures). Slack or broken braces (braced timber frame structures).	
Grade 5	Destruction (very heavy structural damage)	Total or near total collapse of entire structure		

APPENDIX 4: SURVEY DATA

BT=Building Type; VC(IMS)=IMS Vulnerability Class; QxxDG columns are Damage Grades assigned based on the Questions 21, 22, 23 and 30 of the questionnaire (Appendix 1).

Ref.	Type	Lat_WGS84	Long_WGS84	BT(NZ)	VC (IMS)	Q21 DG	Q22 DG	Q23 DG	Q30 DG
1	Work	-43.546	172.643	4	DE			5	1
2	Residential	-43.523	172.631	4	DE		1	1	1
3	Work	-43.557	172.702	5	E		3	5	3
4	Residential	-43.523	172.631	5	E		1	1	3
5	Residential	-43.523	172.634	3	C		1	2	1
6	Dairy (shop)	-43.521	172.639	2	B		1	1	1
7	Residential	-43.521	172.637	5	E		1	1	1
8	Motel	-43.524	172.636	5	E		1	2	1
9	Residential	-43.489	172.623	5	E			6	1
10	Dairy (shop)	-43.518	172.636	2	B			6	1
11	Residential	-43.514	172.641	3	C	4.5	3	3	2
12	Residential	-43.515	172.632	3	C		1	2	1
13	Residential	-43.519	172.630	2	B			1	1
14	Hotel	-43.527	172.612	5	E		1	3	1
15	Residential	-43.520	172.610	3	C		3	5	4
16	Golf Club	-43.535	172.617	4	DE		1	2	1
17	Info centre	-43.533	172.627	5	E		1	2	1
18	Museum	-43.532	172.636	2	B		1	2	1
19	School	-43.528	172.629	4	DE		1	1	2
20	Restaurant	-43.664	172.482	1	NULL		3	3	
21	Clinic	-43.533	172.628	3.5	CD			1	3
22	Restaurant	-43.531	172.629	3	C		1	1	2
23	Casino	-43.526	172.633	5	E		1	2	1
24	Residential	-43.530	172.611	3	CD	4	2	1	2
25	Residential	-43.521	172.658	5	E			4	4
26	Residential	-43.535	172.619	4	DE			2	2
27	Residential	-43.540	172.629	5	E		3	2	1
28	Residential	-43.539	172.621	3	C		1	2	3
29	Café	-43.535	172.628	4	DE		1	1	2
30	Residential	-43.531	172.604	5	E	1		3	1
31	Office	-43.528	172.640	3	C			4	2
32	Residential	-43.546	172.613	5	E			2	1

Ref.	Type	Lat_WGS84	Long_WGS84	BT(NZ)	VC (IMS)	Q21 DG	Q22 DG	Q23 DG	Q30 DG
33	Residential	-43.544	172.621	5	E			2	1
34	Shop	-43.540	172.616	5	E		1	1	1
35	Residential	-43.543	172.609	3	C		1	2	3
36	Office	-43.540	172.615	5	E		1	2	1
37	Shop	-43.537	172.650	4	DE			2	1
38	Garage	-43.537	172.647	5	E		3	3	1
39	Residential	-43.603	172.723	5	E	3		3	1
40	Industry	-43.532	172.636	5	E		1	1	3
41	Office	-43.534	172.630	4	DE		1	1	3
42	Café	-43.534	172.628	3	C		1	2	3
43	Office	-43.537	172.634	5	E			2	1
46	Residential	-43.544	172.624	5	E		1	2	3
47	Office	-43.541	172.615	5	E		1	2	2
48	Residential	-43.535	172.611	4	DE	4	1	1	1
49	Residential	-43.605	172.725	3	C		3	1	4
50	Residential	-43.604	172.726	4	DE		1	2	3
51	Residential	-43.601	172.725	4	DE		1	1	1
52	Residential	-43.542	172.532	5	E		2	2	2
53	Commercial	-43.533	172.659	4	DE		1	2	1
54	Shop	-43.539	172.651	4	DE		1	1	1
55	Shop	-43.538	172.651	4	DE		1	3	1
56	Residential	-43.604	172.722	5	E		1	2	2
57	Residential	-43.521	172.627	4	DE		3	1	3
58	Old bank	-43.521	172.651	4	DE				3
59	Old Pharm	-43.521	172.651	4	DE		2	3	3
60	Residential	-43.601	172.714	4	DE	4.5	1	5	5
61	Residential	-43.603	172.713	4	DE		2	3	2
62	Residential	-43.531	172.654	4	DE	4.5	3	3	1
63	Motel	-43.532	172.646	4	DE		1	2	1
64	Library	-43.494	172.607	5	E			1	1
65	Cricket Club	-43.532	172.636	4	DE			3	3
66	Residential	-43.542	172.657	4	DE			1	3
67	Residential	-43.577	172.710	5	E		1	4	2
68	School	-43.537	172.655	4	DE		1	1	3
69	Residential	-43.576	172.707	5	E		1	4	3
70	Residential	-43.582	172.707	4	DE	2	3	4	1

Ref.	Type	Lat_WGS84	Long_WGS84	BT(NZ)	VC (IMS)	Q21 DG	Q22 DG	Q23 DG	Q30 DG
71	Residential	-43.578	172.705	4	DE	2	3	3	1
72	Residential	-43.573	172.702	5	E		1	2	1
73	School	-43.579	172.709	4	DE			4	5
74	Residential	-43.489	172.612	5	E			1	1
75	Shop	-43.494	172.608	4	DE		1	2	1
76	Residential	-43.576	172.713	5	E	1	1	4	4
78	Residential	-43.566	172.681	4	DE			4	4
79	Residential	-43.577	172.709	5	E		1		3
80	Residential	-43.581	172.715	5	E		3		4
81	Residential	-43.493	172.604	5	E		1	2	1
82	Residential	-43.557	172.714	5	E		1		1
83	Residential	-43.479	172.598	5	E		1	1	1
84	Residential	-43.480	172.609	5	E			1	1
85	Residential	-43.493	172.604	3	C			1	1
86	Residential	-43.492	172.602	5	E		1		1
87	Shop	-43.544	172.637	4	DE		3	4	1
88	Shop	-43.541	172.643	5	E			2	1
89	Christian cnt	-43.540	172.637	5	E		1	2	1
90	Café	-43.535	172.644	4	DE				2
91	Shop	-43.535	172.646	4	DE		1	2	1
92	Residential	-43.479	172.615	4	DE		2	2	1
93	Residential	-43.479	172.625	4	DE			1	1
94	Residential	-43.487	172.589	4	DE	1	1	1	1
95	Residential	-43.495	172.591	4.5	DE	1		1	1
96	Residential	-43.547	172.630	5	E		1	1	1
97	Residential	-43.502	172.614	3	C	3	1	2	1
98	Residential	-43.502	172.623	5	E		2	3	1
99	Residential	-43.508	172.619	3	C	2	2	2	2
100	Residential	-43.515	172.621	4	DE		1	1	2
101	Residential	-43.532	172.636	3	C	4.5	1	2	3
102	Residential	-43.514	172.608	3	C	2	3	3	3
103	Residential	-43.507	172.611	3	C		3		3
104	Shop	-43.535	172.649	5	E		1	3	3
105	Shop	-43.537	172.647	5	E		1	1	3
106	Residential	-43.505	172.665	4	DE		1	1	1
107	Residential	-43.504	172.664	4	DE		1		3

Ref.	Type	Lat_WGS84	Long_WGS84	BT(NZ)	VC (IMS)	Q21 DG	Q22 DG	Q23 DG	Q30 DG
108	Residential	-43.504	172.664	4	DE	1	1	2	2
109	Residential	-43.504	172.662	3	C		1	1	3
110	Residential	-43.506	172.662	4	DE			1	1
111	Church	-43.508	172.663	3	C		1	1	3
112	Residential	-43.509	172.665	4	DE		2		1
113	Residential	-43.543	172.616	5	E			1	1
114	Residential	-43.544	172.616	4	DE		1	1	1
115	Studio	-43.543	172.615	5	E			1	1
116	Residential	-43.539	172.621	5	E			1	1
117	Residential	-43.524	172.646	5	E				3
118	Shop	-43.529	172.645	4	DE		2		1
119	Pub	-43.527	172.649	2	B		3	2	2
120	Residential	-43.528	172.656	3	C	3	1	2	1
121	Residential	-43.530	172.661	3	C		1	3	2
122	Swim pool	-43.566	172.614						1
123	Residential	-43.567	172.622	5	E		1	4	3
124	Residential	-43.568	172.625	4	DE	2	2		1
125	Residential	-43.564	172.626	3	C		1	1	3
126	Residential	-43.565	172.629	3	C	2	1	4	2
127	Residential	-43.573	172.629	4	DE		1	3	3
128	Residential	-43.532	172.636	4	DE	2	3		1
129	Residential	-43.515	172.669	3	C		1	3	2
130	Residential	-43.525	172.674	3	C	4.5	1	1	3
131	Residential	-43.525	172.679	5	E		1	2	1
132	Residential	-43.525	172.682	4	DE	1	1	3	1
133	Residential	-43.527	172.683	4	DE			5	4
134	Residential	-43.526	172.684	4	DE	4.5	1	4	3
135	Residential	-43.517	172.702	4	DE			5	4
136	Residential	-43.576	172.624	3	C		2	1	2
137	Residential	-43.570	172.624	3	C		3	3	2
138	Residential	-43.573	172.619	5	E		2		3
139	Residential	-43.564	172.622	4	DE		1	2	2
140	Residential	-43.471	172.615	4	DE	1	1		2
141	Commercial	-43.522	172.656					4	
142	Residential	-43.470	172.611	5	E	1	1	1	1
143	Residential	-43.472	172.609	5	E		1	2	1

Ref.	Type	Lat_WGS84	Long_WGS84	BT(NZ)	VC (IMS)	Q21 DG	Q22 DG	Q23 DG	Q30 DG
144	Residential	-43.469	172.610	5	E		1	2	1
145	Residential	-43.561	172.654	4	DE		1	1	1
146	Residential	-43.563	172.662	4	DE		2		4
147	Residential	-43.553	172.660	4	DE			1	3
148	Residential	-43.537	172.681	4	DE	4	1		3
149	Residential	-43.542	172.694	4	DE		2	3	3
150	Residential	-43.513	172.732	3	C		1		3
151	Residential	-43.505	172.719	3	C	2	2	1	4
152	Residential	-43.495	172.719	4	DE	2	1	1	3
153	Residential	-43.494	172.719	5	E		2	2	1
154	School	-43.495	172.718	4	DE		2		3
155	Residential	-43.495	172.716	4	DE		3	3	4
156	Motel	-43.531	172.586	4	DE		3	2	2
161	Recycle cnt	-43.467	172.612	5	E		1	1	1
162	Residential	-43.468	172.618	5	E		1	1	2
163	Residential	-43.537	172.567	4	DE				2
164	Residential	-43.538	172.566	4	DE		1	2	1
165	Residential	-43.535	172.569	4	DE			1	2
166	Residential	-43.548	172.493	4	DE			2	1

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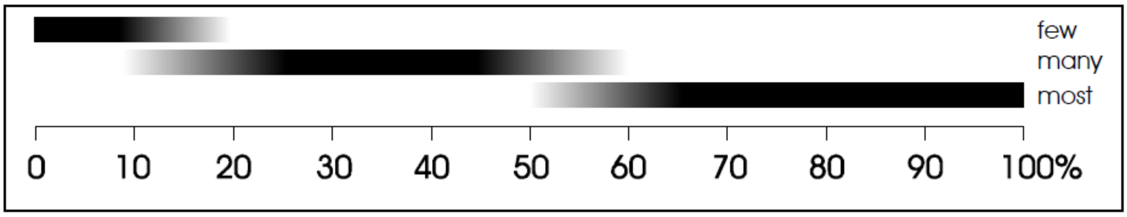
APPENDIX 5: EQUIVALENT PERCENTAGES FOR "FEW", "MANY" AND "MOST" DESCRIPTIONS OF BUILDING TYPES THAT HAVE EXPERIENCED A GIVEN DAMAGE GRADE

The use of these descriptors with respect to building type and damage grade to assign IMS-based MMI is also shown below.

Definitions of quantity



Definitions of intensity degrees

Arrangement of the scale:

a) Effects on humans

b) Effects on objects and on nature
(effects on ground and ground failure are dealt with especially in Section 7)

c) Damage to buildings

Introductory remark:

The single intensity degrees can include the effects of shaking of the respective lower intensity degree(s) also, when these effects are not mentioned explicitly.

I. Not felt

a) Not felt, even under the most favourable circumstances.

b) No effect.

c) No damage.

II. Scarcely felt

a) The tremor is felt only at isolated instances (<1%) of individuals at rest and in a specially receptive position indoors.

b) No effect.

c) No damage.

III. Weak

a) The earthquake is felt indoors by a few. People at rest feel a swaying or light trembling.
b) Hanging objects swing slightly.
c) No damage.

IV. Largely observed

a) The earthquake is felt indoors by many and felt outdoors only by very few. A few people are awakened. The level of vibration is not frightening. The vibration is moderate. Observers feel a slight trembling or swaying of the building, room or bed, chair etc.
b) China, glasses, windows and doors rattle. Hanging objects swing. Light furniture shakes visibly in a few cases. Woodwork creaks in a few cases.
c) No damage.

V. Strong

a) The earthquake is felt indoors by most, outdoors by few. A few people are frightened and run outdoors. Many sleeping people awake. Observers feel a strong shaking or rocking of the whole building, room or furniture.
b) Hanging objects swing considerably. China and glasses clatter together. Small, top-heavy and/or precariously supported objects may be shifted or fall down. Doors and windows swing open or shut. In a few cases window panes break. Liquids oscillate and may spill from well-filled containers. Animals indoors may become uneasy.
c) Damage of grade 1 to a few buildings of vulnerability class A and B.

VI. Slightly damaging

a) Felt by most indoors and by many outdoors. A few persons lose their balance. Many people are frightened and run outdoors.
b) Small objects of ordinary stability may fall and furniture may be shifted. In few instances dishes and glassware may break. Farm animals (even outdoors) may be frightened.
c) Damage of grade 1 is sustained by many buildings of vulnerability class A and B; a few of class A and B suffer damage of grade 2; a few of class C suffer damage of grade 1.

VII. Damaging

a) Most people are frightened and try to run outdoors. Many find it difficult to stand, especially on upper floors.
b) Furniture is shifted and top-heavy furniture may be overturned. Objects fall from shelves in large numbers. Water splashes from containers, tanks and pools.
c) Many buildings of vulnerability class A suffer damage of grade 3; a few of grade 4.
Many buildings of vulnerability class B suffer damage of grade 2; a few of grade 3.
A few buildings of vulnerability class C sustain damage of grade 2.
A few buildings of vulnerability class D sustain damage of grade 1.

VIII. Heavily damaging

a) Many people find it difficult to stand, even outdoors.
b) Furniture may be overturned. Objects like TV sets, typewriters etc. fall to the ground. Tombstones may occasionally be displaced, twisted or overturned. Waves may be seen on very soft ground.
c) Many buildings of vulnerability class A suffer damage of grade 4; a few of grade 5.
Many buildings of vulnerability class B suffer damage of grade 3; a few of grade 4.
Many buildings of vulnerability class C suffer damage of grade 2; a few of grade 3.
A few buildings of vulnerability class D sustain damage of grade 2.

IX. Destructive

a) General panic. People may be forcibly thrown to the ground.
b) Many monuments and columns fall or are twisted. Waves are seen on soft ground.
c) Many buildings of vulnerability class A sustain damage of grade 5.
Many buildings of vulnerability class B suffer damage of grade 4; a few of grade 5.
Many buildings of vulnerability class C suffer damage of grade 3; a few of grade 4.
Many buildings of vulnerability class D suffer damage of grade 2; a few of grade 3.
A few buildings of vulnerability class E sustain damage of grade 2.

X. Very destructive

c) Most buildings of vulnerability class A sustain damage of grade 5.
Many buildings of vulnerability class B sustain damage of grade 5.
Many buildings of vulnerability class C suffer damage of grade 4; a few of grade 5.
Many buildings of vulnerability class D suffer damage of grade 3; a few of grade 4.
Many buildings of vulnerability class E suffer damage of grade 2; a few of grade 3.
A few buildings of vulnerability class F sustain damage of grade 2.

XI. Devastating

c) Most buildings of vulnerability class B sustain damage of grade 5.
Most buildings of vulnerability class C suffer damage of grade 4; many of grade 5.
Many buildings of vulnerability class D suffer damage of grade 4; a few of grade 5.
Many buildings of vulnerability class E suffer damage of grade 3; a few of grade 4.
Many buildings of vulnerability class F suffer damage of grade 2; a few of grade 3.

XII. Completely devastating

c) All buildings of vulnerability class A, B and practically all of vulnerability class C are destroyed. Most buildings of vulnerability class D, E and F are destroyed. The earthquake effects have reached the maximum conceivable effects.

APPENDIX 6: TABLES USED TO DEVELOP MMI FROM SURVEY DATA ACQUIRED WITHIN 500M AND 2KM OF THE STRONG MOTION ACCELEROGRAPH STATIONS

The relevant strong motion station is listed at the top of each table. MMI is developed from building type, vulnerability class, damage grade, and few/many/most assignments. Each Table addresses one of the four key questions from the survey, the rows distinguish each damage grade, and the columns distinguish each building type or vulnerability class (e.g. Q30 4 signifies question 30 and damage grade 4). Beneath the tables are the row totals, equivalent percentages, and MMI assignments based on the percentages and corresponding few/many/most assignments.

SEARCH RADIUS = 500m

Station CCCC

Building Type

	null		2	3	3.5	4	4.5	5
total nu	1		2	6	1	19		14
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						3		2
Q22 2								
Q22 3								1
Q23 1						1		1
Q23 2						2		1
Q23 3						1		2
Q23 4								
Q23 5								
Q23 6								
Q30 1						4		2
Q30 2						1		
Q30 3								2
Q30 4								
Q30 5								
1			0	0	0	8	0	5
2			0	0	0	3	0	1
3			0	0	0	1	0	5
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	0	0	67	0	45
2	0	0	0	0	0	25	0	9
3	0	0	0	0	0	8	0	45
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

	MM
MANY VCDE/DG2 FEW DG3	9
MANY VCE/DG3	11

Station CHHC

Building Type

	null		2	3	3.5	4	4.5	5
total nu	1		3	8	1	18		25
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1				1		2		1
Q22 2								
Q22 3								
Q23 1					1	2		
Q23 2				1				1
Q23 3								
Q23 4								
Q23 5								
Q23 6								
Q30 1								1
Q30 2						1		
Q30 3				1	1	1		
Q30 4								
Q30 5								
1			0	1	1	4	0	2
2			0	1	0	1	0	1
3			0	1	1	1	0	0
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	33	50	67	0	67
2	0	0	0	33	0	17	0	33
3	0	0	0	33	50	17	0	0
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

FEW=0-20%
MANY=20-50%
MOST=50-100%

	MM
MANY VCC/DG2 MANY DG3	8
MANY ' D	9
MANY VCDE/DG3	10

Station SHLC

Building Type

	null		2	3	3.5	4	4.5	5
total nu	1			4		7		1
VC	A		B	C	CD	DE	DE	E
Q21 1						1		
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1				2		3		
Q22 2						1		
Q22 3								
Q23 1				2		2		
Q23 2						1		
Q23 3								
Q23 4								
Q23 5								
Q23 6								
Q30 1						3		
Q30 2						1		
Q30 3				2		1		
Q30 4								
Q30 5								
1			0	4	0	9	0	0
2			0	0	0	3	0	0
3			0	2	0	1	0	0
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	67	0	69	0	0
2	0	0	0	0	0	23	0	0
3	0	0	0	33	0	8	0	0
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

	MM
MANY VCC/DG3	9
MANY VCDE/DG2 FEW DG3	9

MANY VCE/DG2 10

MEAN 10 MEAN 9 MEAN 9

Station CMHS

	Building Type							
	null		2	3	3.5	4	4.5	5
total nu	1			4		3		2
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2				1		1		
Q21 3								
Q21 4								
Q21 4.5								
Q22 1				2		1		1
Q22 2						1		
Q22 3								
Q23 1				1				
Q23 2						1		
Q23 3								
Q23 4				1				1
Q23 5								
Q23 6								
Q30 1						1		
Q30 2				1		1		
Q30 3				1				1
Q30 4								
Q30 5								
1			0	3	0	2	0	1
2			0	2	0	4	0	0
3			0	1	0	0	0	1
4			0	1	0	0	0	1
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages DG for given VC								
1	0	0	0	43	0	33	0	33
2	0	0	0	29	0	67	0	0
3	0	0	0	14	0	0	0	33
4	0	0	0	14	0	0	0	33
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

MM

Station SMTC

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings						3		8
VC	A		B	C	CD	DE	DE	E
Q21 1						1		1
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		4
Q22 2								
Q22 3								
Q23 1								3
Q23 2								1
Q23 3								
Q23 4								
Q23 5								
Q23 6								
Q30 1								4
Q30 2						1		1
Q30 3								
Q30 4								
Q30 5								
1			0	0	0	2	0	12
2			0	0	0	1	0	2
3			0	0	0	0	0	0
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	0	0	67	0	86
2	0	0	0	0	0	33	0	14
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

MM

Station REHS

	Building Type							
	null		2	3	3.5	4	4.5	5
total nu	2		5	8	1	16		14
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1			1	1		1		4
Q22 2								
Q22 3								
Q23 1			1			1		2
Q23 2				1				2
Q23 3								
Q23 4								
Q23 5								
Q23 6			1					
Q30 1			2	1		1		3
Q30 2								
Q30 3								1
Q30 4								
Q30 5								
1			4	2	0	3	0	9
2			0	1	0	0	0	2
3			0	0	0	0	0	1
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			1	0	0	0	0	0
Percentages								
1	0	0	80	67	0	100	0	75
2	0	0	0	33	0	0	0	17
3	0	0	0	0	0	0	0	8
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	20	0	0	0	0	0

MM

MANY VCC/DG2 FEW DG3-4	9	MANY VCDE/DG2	9
MOST VCDE/DG2		FEW VCE/DG2	10
MANY VCE/DG3-4	11		

FEW=0-20%
MANY=20-50%
MOST=50-100%

MANY VCC/DG2	8
FEW VCE/DG2-3	10

MEAN 10 MEAN 10 MEAN 9

Station LPCC

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings				1		4		2
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								1
Q21 4								
Q21 4.5								
Q22 1						1		1
Q22 2								
Q22 3				1				
Q23 1				1				
Q23 2						1		1
Q23 3								1
Q23 4								
Q23 5								
Q23 6								
Q30 1								1
Q30 2								1
Q30 3						1		
Q30 4				1				
Q30 5								
1			0	1	0	1	0	2
2			0	0	0	1	0	2
3			0	1	0	1	0	2
4			0	1	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages DG for given VC								
1	0	0	0	33	0	33	0	33
2	0	0	0	0	0	33	0	33
3	0	0	0	33	0	33	0	33
4	0	0	0	33	0	0	0	0
4.5	0	0	0	0	0	0	0	0

Station NNBS

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings				1		3		1
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2						1		
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		
Q22 2						1		1
Q22 3						1		
Q23 1						1		
Q23 2								1
Q23 3						1		
Q23 4								
Q23 5								
Q23 6								
Q30 1								1
Q30 2								
Q30 3						2		
Q30 4						1		
Q30 5								
1			0	0	0	2	0	1
2			0	0	0	2	0	2
3			0	0	0	4	0	0
4			0	0	0	1	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	0	0	22	0	33
2	0	0	0	0	0	22	0	67
3	0	0	0	0	0	44	0	0
4	0	0	0	0	0	11	0	0
4.5	0	0	0	0	0	0	0	0

Station PPHS

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings				4		3	1	8
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		2
Q22 2								
Q22 3								
Q23 1				1				
Q23 2						1		1
Q23 3								
Q23 4								
Q23 5								
Q23 6								
Q30 1				1		1		3
Q30 2								
Q30 3								
Q30 4								
Q30 5								
1			0	2	0	2	0	5
2			0	0	0	1	0	1
3			0	0	0	0	0	0
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages DG for given VC								
1	0	0	0	100	0	67	0	83
2	0	0	0	0	0	33	0	17
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0

5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0

	MM			MM		MM
MANY VCC/DG3-4	9	FEW=0-20%	MANY VCDE/DG2-3 FEW DG4	10	MANY VCDE/DG2	10
MANY VCDE/DG2-3	8	MANY=20-50%	MOST VCE/DG2		FEW VCE/DG2	10
MANY VCE/DG2-3	9	MOST=50-100%				
MEAN	9		MEAN	10	MEAN	10

SEARCH RADIUS = 2km

Station CBGS

				Building Type				
	null		2	3	3.5	4	4.5	5
total nu	1		5	11	1	12		20
VC	A		B	C	CD	DE	DE	E
Q21 1								1
Q21 2				1		1		
Q21 3								
Q21 4				1		1		
Q21 4.5				1				
Q22 1			2	7		8		12
Q22 2				1				
Q22 3				2		2		1
Q23 1			2	2	1	8		7
Q23 2			1	6		2		11
Q23 3				1		1		2
Q23 4				1				
Q23 5				1				
Q23 6			1					
Q30 1			4	1		5		16
Q30 2				3		4		1
Q30 3				5	1	3		3
Q30 4				1				
Q30 5								
1			8	10	1	21	0	36
2			1	11	0	7	0	12
3			0	8	1	6	0	6
4			0	3	0	1	0	0
4.5			0	1	0	0	0	0
5			0	1	0	0	0	0
6			1	0	0	0	0	0
Percentages DG for given VC								
1	0	0	80	29	50	60	0	67
2	0	0	10	32	0	20	0	22
3	0	0	0	24	50	17	0	11
4	0	0	0	9	0	3	0	0
4.5	0	0	0	3	0	0	0	0
5	0	0	0	3	0	0	0	0
6	0	0	10	0	0	0	0	0

	MM
MOST VCE/DG1	
MANY VCE/DG2 FEW DG3	10
MOST VCDE/DG1 MANY DG2-3	9

FEW=0-20%
MANY=20-50%

Station CCCC

				Building Type				
	null		2	3	3.5	4	4.5	5
total nu	1		2	6	1	19		14
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2						1		
Q21 3				1				
Q21 4								
Q21 4.5				1		1		
Q22 1			1	5		9		9
Q22 2						1		
Q22 3			1			3		2
Q23 1				1	1	7		3
Q23 2			2	3		4		8
Q23 3				1		3		2
Q23 4				1		1		
Q23 5						1		
Q23 6								
Q30 1			1	1		11		9
Q30 2			1	3		3		
Q30 3				2	1	5		5
Q30 4								
Q30 5								
1			2	7	1	27	0	21
2			3	6	0	9	0	8
3			1	4	1	11	0	9
4			0	1	0	1	0	0
4.5			0	1	0	1	0	0
5			0	0	0	1	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	33	37	50	54	0	55
2	0	0	50	32	0	18	0	21
3	0	0	17	21	50	22	0	24
4	0	0	0	5	0	2	0	0
4.5	0	0	0	5	0	2	0	0
5	0	0	0	0	0	2	0	0
6	0	0	0	0	0	0	0	0

	MM
MOST VCE/DG1	
MANY VCE/DG2-3	10
MOST VCDE/DG1 MANY DG3	10

Station CHHC

				Building Type				
	null		2	3	3.5	4	4.5	5
total nu	1		3	8	1	18		25
VC	A		B	C	CD	DE	DE	E
Q21 1								1
Q21 2						1		
Q21 3								
Q21 4				1		1		
Q21 4.5				1				
Q22 1			2	6		9		15
Q22 2				1		1		
Q22 3						3		2
Q23 1			2	2	1	7		9
Q23 2			1	5		5		12
Q23 3						1		4
Q23 4				1		1		
Q23 5						1		
Q23 6								
Q30 1			3	1		11		19
Q30 2				3		4		1
Q30 3				4	1	3		5
Q30 4								
Q30 5								
1			7	9	1	27	0	44
2			1	9	0	11	0	13
3			0	4	1	7	0	11
4			0	2	0	2	0	0
4.5			0	1	0	0	0	0
5			0	0	0	1	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	88	36	50	56	0	65
2	0	0	13	36	0	23	0	19
3	0	0	0	16	50	15	0	16
4	0	0	0	8	0	4	0	0
4.5	0	0	0	4	0	0	0	0
5	0	0	0	0	0	2	0	0
6	0	0	0	0	0	0	0	0

	MM
MOST VCE/DG1	
FEW VCE/DG2-3	9
MOST \ D	

MANY VCC/DG1-3 8 MOST=50-100%

MEAN 9

MANY VCC/DG1-3 FEW DG4-4.5 9
MANY VCB/DG1-2 FEW DG3 7

MEAN 9

MANY VCDE/DG2 10
MANY VCC/DG1-2 8
MOST VCB/DG1 FEW DG2

MEAN 9

Station CMHS

			Building Type					
	null		2	3	3.5	4	4.5	5
total nu	1			4		3		2
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2				1		1		
Q21 3								
Q21 4								
Q21 4.5								
Q22 1				2		2		1
Q22 2				1		1		1
Q22 3				1				
Q23 1				2				
Q23 2						1		
Q23 3				1		1		
Q23 4				1				1
Q23 5								
Q23 6			1					
Q30 1			4			1		
Q30 2			1	3		1		
Q30 3				1		1		2
Q30 4								
Q30 5								
1			4	4	0	3	0	1
2			1	5	0	4	0	1
3			0	3	0	2	0	2
4			0	1	0	0	0	1
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			1	0	0	0	0	0
Percentages DG for given VC								
1	0	0	67	31	0	33	0	20
2	0	0	17	38	0	44	0	20
3	0	0	0	23	0	22	0	40
4	0	0	0	8	0	0	0	20
4.5	0	0	0	0	0	0	0	0

Station HPSC

			Building Type					
	`		2	3	3.5	4	4.5	5
total number of buildings				1		4		1
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2				1		1		
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		
Q22 2				1		1		1
Q22 3						1		
Q23 1				1		1		
Q23 2								1
Q23 3						1		
Q23 4								
Q23 5						1		
Q23 6								
Q30 1								1
Q30 2								
Q30 3						2		
Q30 4				1		2		
Q30 5								
1			0	1	0	2	0	1
2			0	2	0	2	0	2
3			0	0	0	4	0	0
4			0	1	0	2	0	0
4.5			0	0	0	0	0	0
5			0	0	0	1	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	25	0	18	0	33
2	0	0	0	50	0	18	0	67
3	0	0	0	0	0	36	0	0
4	0	0	0	25	0	18	0	0
4.5	0	0	0	0	0	0	0	0

Station HVSC

			Building Type					
	null		2	3	3.5	4	4.5	5
total number of buildings				1		7		7
VC	A		B	C	CD	DE	DE	E
Q21 1								1
Q21 2						2		
Q21 3								1
Q21 4								
Q21 4.5						1		
Q22 1						3		5
Q22 2						1		
Q22 3				1		2		1
Q23 1				1		1		
Q23 2						1		1
Q23 3						2		1
Q23 4						2		3
Q23 5						1		
Q23 6								
Q30 1						3		1
Q30 2						1		2
Q30 3						1		2
Q30 4				1				2
Q30 5						2		
1			0	1	0	7	0	7
2			0	0	0	5	0	3
3			0	1	0	5	0	5
4			0	1	0	2	0	5
4.5			0	0	0	1	0	0
5			0	0	0	3	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	33	0	30	0	35
2	0	0	0	0	0	22	0	15
3	0	0	0	33	0	22	0	25
4	0	0	0	33	0	9	0	25
4.5	0	0	0	0	0	4	0	0

5	0	0	0	0	0	0	0	0
6	0	0	17	0	0	0	0	0

MM

FEW VCB/DG2	
MANY VCC/DG2-3 FEW DG4	9
MANY VCDE/DG1-3	8
MANY VCE/DG3 FEW DG4	11
MEAN	9

FEW=0-20%
MANY=20-50%
MOST=50-100%

5	0	0	0	0	0	9	0	0
6	0	0	0	0	0	0	0	0

MM

MANY VCC/DG2 FEW DG4	8
MANY VCDE/DG3 FEW DG4	10
MOST VCE/DG2	
MEAN	9

5	0	0	0	0	0	13	0	0
6	0	0	0	0	0	0	0	0

MM

MANY VCC/DG3-4	9
MANY VCDE/DG3 FEW DG4-5	10
MANY VCE/DG3-4	11
MEAN	10

Station LPCC

Building Type

	null		2	3	3.5	4	4.5	5
total number of buildings				1		4		2
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								1
Q21 4								
Q21 4.5						1		
Q22 1						3		1
Q22 2						1		
Q22 3				1				
Q23 1						1		
Q23 2						1		1
Q23 3				1		1		1
Q23 4								
Q23 5						1		
Q23 6								
Q30 1						1		1
Q30 2						1		1
Q30 3						1		
Q30 4				1				
Q30 5						1		
1			0	0	0	5	0	2
2			0	0	0	3	0	2
3			0	2	0	2	0	2
4			0	1	0	0	0	0
4.5			0	0	0	1	0	0
5			0	0	0	2	0	0
6			0	0	0	0	0	0

Percentages DG for given VC

Station NNBS

Building Type

	null		2	3	3.5	4	4.5	5
total number of buildings				1		3		1
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2				1		1		
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		
Q22 2				1		1		1
Q22 3						1		
Q23 1				1		1		
Q23 2								1
Q23 3						1		
Q23 4								
Q23 5								
Q23 6								
Q30 1								1
Q30 2								
Q30 3						2		
Q30 4				1		1		
Q30 5								
1			0	1	0	2	0	1
2			0	2	0	2	0	2
3			0	0	0	4	0	0
4			0	1	0	1	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0

Percentages

Station SMTC

Building Type

	null		2	3	3.5	4	4.5	5
total number of buildings						3		8
VC	A		B	C	CD	DE	DE	E
Q21 1						1		1
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		6
Q22 2						1		
Q22 3								
Q23 1						1		5
Q23 2						1		2
Q23 3								
Q23 4								
Q23 5								
Q23 6								
Q30 1						2		7
Q30 2						1		1
Q30 3								
Q30 4								
Q30 5								
1			0	0	0	5	0	19
2			0	0	0	3	0	3
3			0	0	0	0	0	0
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0

Percentages

1	0	0	0	0	0	38	0	33
2	0	0	0	0	0	23	0	33
3	0	0	0	67	0	15	0	33
4	0	0	0	33	0	0	0	0
4.5	0	0	0	0	0	8	0	0
5	0	0	0	0	0	15	0	0
6	0	0	0	0	0	0	0	0

	MM	
MOST VCC/DG3 MANY DG4	9	FEW=0-20%
MANY VCDE/DG3 FEW DG4-5	10	MANY=20-50%
MANY VCE/DG2-3	10	MOST=50-100%
MEAN	10	

1	0	0	0	25	0	22	0	33
2	0	0	0	50	0	22	0	67
3	0	0	0	0	0	44	0	0
4	0	0	0	25	0	11	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

	MM
MANY VCC/DG2 MANY DG4	10
MANY VCDE/DG3 FEW DG4	10
MOST VCE/DG2	
MEAN	10

FEW=0-20%
MANY=20-50%
MOST=50-100%

1	0	0	0	0	0	63	0	86
2	0	0	0	0	0	38	0	14
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

	MM
MANY VCDE/DG2	10
FEW VCE/D2	10
MEAN	10

Station PPHS

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings				4		3	1	8
VC	A		B	C	CD	DE	DE	E
Q21 1						1	1	
Q21 2				1				
Q21 3				1				
Q21 4								
Q21 4.5								
Q22 1				1		2		3
Q22 2				1		1		1
Q22 3				1				
Q23 1				1		1	1	4
Q23 2				2		2		1
Q23 3								1
Q23 4								
Q23 5								
Q23 6								1
Q30 1				2		3	1	8
Q30 2				1				
Q30 3				1				
Q30 4								
Q30 5								
1			0	4	0	7	3	15
2			0	5	0	3	0	2

Station PRPC

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings						5		1
VC	A		B	C	CD	DE	DE	E
Q21 1						1		
Q21 2								
Q21 3								
Q21 4								
Q21 4.5						1		
Q22 1						2		1
Q22 2						1		
Q22 3								
Q23 1								
Q23 2								1
Q23 3						2		
Q23 4						1		
Q23 5						2		
Q23 6								
Q30 1						1		1
Q30 2								
Q30 3						2		
Q30 4						2		
Q30 5								
1			0	0	0	4	0	2
2			0	0	0	1	0	1

Station REHS

	Building Type							
	null		2	3	3.5	4	4.5	5
total nu	2		5	8	1	16		14
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2						1		
Q21 3				1				
Q21 4								
Q21 4.5				2		1		
Q22 1			2	6		7		10
Q22 2						2		
Q22 3			1	1		3		1
Q23 1			2	1	1	6		4
Q23 2			2	5		3		5
Q23 3				1		3		3
Q23 4				1				1
Q23 5								
Q23 6			1					
Q30 1			4	3		6		8
Q30 2			1	3		5		
Q30 3				2	1	5		5
Q30 4								1
Q30 5								
1			8	10	1	19	0	22
2			3	8	0	11	0	5

3			0	3	0	0	0	1
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	1
Percentages DG for given VC								
1	0	0	0	33	0	70	100	79
2	0	0	0	42	0	30	0	11
3	0	0	0	25	0	0	0	5
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	5

	MM
MANY VCC/DG2-3	8
MANY VCDE/DG2	9
FEW VCE/DG2-3	9
MEAN	9

FEW=0-20%
MANY=20-50%
MOST=50-100%

3			0	0	0	4	0	0
4			0	0	0	3	0	0
4.5			0	0	0	1	0	0
5			0	0	0	2	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	0	0	27	0	67
2	0	0	0	0	0	7	0	33
3	0	0	0	0	0	27	0	0
4	0	0	0	0	0	20	0	0
4.5	0	0	0	0	0	7	0	0
5	0	0	0	0	0	13	0	0
6	0	0	0	0	0	0	0	0

	MM
MANY VCDE/DG3 FEW DG4-5	10
MANY VCE/DG2	10
MEAN	10

3			1	5	1	11	0	9
4			0	1	0	0	0	2
4.5			0	2	0	1	0	0
5			0	0	0	0	0	0
6			1	0	0	0	0	0
Percentages								
1	0	0	62	38	50	45	0	58
2	0	0	23	31	0	26	0	13
3	0	0	8	19	50	26	0	24
4	0	0	0	4	0	0	0	5
4.5	0	0	0	8	0	2	0	0
5	0	0	0	0	0	0	0	0
6	0	0	8	0	0	0	0	0

	MM
MANY VCB/DG2 FEW DG3	7
MANY VCC/DG2 FEW DG3-4	8
MANY VCCD/DG3	9
MANY VCDE/DG2-3 FEW DG4.5	9
MANY VCE/DG3 FEW DG4	11
MEAN	9

Station RHSC

	Building Type							
	null		2	3	3.5	4	4.5	5
total number of buildings						4		
VC	A		B	C	CD	DE	DE	E
Q21 1								
Q21 2								
Q21 3								
Q21 4								
Q21 4.5								
Q22 1						1		
Q22 2								
Q22 3						1		
Q23 1						1		
Q23 2						2		
Q23 3								
Q23 4								
Q23 5								
Q23 6								
Q30 1						1		

Station SHLC

	Building Type							
	null		2	3	3.5	4	4.5	5
total nu	1			4		7		1
VC	A		B	C	CD	DE	DE	E
Q21 1						1		
Q21 2								
Q21 3								
Q21 4								
Q21 4.5				1				
Q22 1				3		3		
Q22 2						2		
Q22 3				1				
Q23 1				2		2		
Q23 2						1		
Q23 3				2		1		
Q23 4								1
Q23 5								
Q23 6								
Q30 1						3		

Q30 2						3		
Q30 3								
Q30 4								
Q30 5								
1			0	0	0	3	0	0
2			0	0	0	5	0	0
3			0	0	0	1	0	0
4			0	0	0	0	0	0
4.5			0	0	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages DG for given VC								
1	0	0	0	0	0	33	0	0
2	0	0	0	0	0	56	0	0
3	0	0	0	0	0	11	0	0
4	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

MM

MOST VCDE/DG2 FEW DG3 10

MEAN 10

Q30 2				2		1		
Q30 3				2		3		
Q30 4								1
Q30 5								
1			0	5	0	9	0	0
2			0	2	0	4	0	0
3			0	5	0	4	0	0
4			0	0	0	0	0	2
4.5			0	1	0	0	0	0
5			0	0	0	0	0	0
6			0	0	0	0	0	0
Percentages								
1	0	0	0	38	0	53	0	0
2	0	0	0	15	0	24	0	0
3	0	0	0	38	0	24	0	0
4	0	0	0	0	0	0	0	100
4.5	0	0	0	8	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

MM

FEW=0-20%
MANY=20-50%
MOST=50-100%

MANY VCC/DG3 FEW DG4.5 9
MANY VCDE/DG2-3 9
MOST VCE/DG4

MEAN 9

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