New Zealand: Summary of Building Types, Vulnerability to Collapse and Occupancy

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WHE Construction Type or Material *refer to Table 2 for suggested category(ies)*	Description of construction type (type of load-bearing structure) *(refer to Tables 2 and 3 for suggested categories and sources of data to help answer this question)*	Estimate of probability of collapse (%) of the building type when subjected to the specified shaking intensity (expressed as a range) *(refer to instructions page 5)* (3) **MMI / EMS / MSK**				Fraction of population who LIVES in this building type *(refer to instructions for help in estimating)*		Fraction of WORKING population who WORKS in this building type *(refer to instructions on page 5 for help in estimating)*		Peak average number of occupants per building *(refer to instructions on page 5 for help in estimating)*
(1)	+ = See next pages for expanded construction type descriptions	IX (~0.65-1.24g)	VIII (~0.34-0.65g)	VII (~0.18-0.34g)	VI (~0.092-.18g)	urban areas (4)	rural areas (5)	urban areas (6)	rural areas (7)	(8)
9	Buildings having walls constructed of solid clay bricks in cement	5.4	0.3	0.0015	0	0.004	0.003	0.008	0.006	
12	Buildings having walls constructed of hollow concrete masonry block	0.3	0.015	0.0001	0	0.019	0.021	0.062	0.058	
14	Buildings having reinforced concrete columns, beams, and flo	1.4	0.08	0.0004	0	0.001	0.001	0.018	0.017	
15	Buildings having reinforced concrete columns, beams, and flo	0.14	0.008	0	0	0.003	0.002	0.039	0.029	
19	Buildings constructed of reinforced concrete shear walls and floor and	0.4	0.02	0.0001	0	0.028	0.018	0.204	0.119	
21	Buildings constructed of reinforced concrete shear walls and floor slab	0.3	0.015	0.0001	0	0.007	0.010	0.032	0.031	
25	Buildings having steel columns and beams that either make up a rigid	0.3	0.015	0.0001	0	0.009	0.022	0.059	0.067	
26	Buildings that are constructed of light steel framing. These are	0.11	0.006	0	0	0.007	0.020	0.033	0.046	
32	Buildings with walls constructed of 2x4" wood studs spaced at 24"	0.07	0.004	0	0	0.919	0.901	0.498	0.582	
34	Buildings having perimeter walls made of large single-height	1.4	0.08	0.0004	0	0.003	0.002	0.047	0.045	
All Classes	Total Indoors Populations (millions)	na	na	na	na	2.325	1.861	1.913	1.470	

Other sources consulted:

Country-wide property valuation database; National Census records

DETAILS FOR COLUMN 2: DESCRIPTION OF CONSTRUCTION TYPE

Construction Type 9: Buildings having walls constructed of solid clay bricks in cement mortar. Floors are typically wood joists covered with boards. The roof framing is usually timber, and the cladding may be a variety of materials including clay or concrete tiles, pressed sheet metal tiles, or corrugated iron. Gravity loads are carried by the walls in compression, and lateral earthquake forces are resisted by shear in the walls. Unreinforced masonry construction has not been permitted in New Zealand since about 1940.

Construction Type 12: Buildings having walls constructed of hollow concrete masonry blocks in cement mortar. The hollow masonry blocks are reinforced by inserting reinforcing steel in the cells and then filling the cells with grout. Floors are typically reinforced concrete. The roof framing is usually timber, and the cladding is usually corrugated iron. Gravity loads are carried by the walls in compression, and lateral earthquake forces are resisted by shear in the walls

Construction Type 14: Buildings having reinforced concrete columns, beams, and floor and roof slabs - pre-1980. The components are usually cast-in-place. Gravity loads are carried by the columns, and lateral earthquake forces are resisted by the rigid moment-resisting frame that is created at the intersection of the beams and columns. Design for seismic resistance was introduced in tha 1940s, but pre-1980 methodologies are now regarded as inadequate. Not common in New Zealand

Construction Type 15: Buildings having reinforced concrete columns, beams, and floor and roof slabs - 1980 onwards. The components may be cast-in-place or factory pre-cast. Gravity loads are carried by the columns, and lateral earthquake forces are resisted by the rigid moment-resisting frame that is created at the intersection of the beams and columns. Not common in New Zealand

Construction Type 19: Buildings constructed of reinforced concrete shear walls and floor and roof slabs. Shear wall buildings typically include columns to carry gravity loads, usually in the interior for low-rise buildings, and on the exterior for medium- and high-rise. Gravity loads are carried by the shear walls and columns, and lateral earthquake forces are resisted by the shear walls. This type of construction is common in New Zealand.

Construction Type 21: Buildings constructed of reinforced concrete shear walls and floor slabs. Roof framing is generally timber and roof cladding corrugated iron or asbestos. Low-rise only. Shear wall buildings may include internal columns to carry gravity loads. Gravity loads are carried by the shear walls and columns, and lateral earthquake forces are resisted by the shear walls. This type of construction is common in New Zealand.

Construction Type 25: Buildings having steel columns and beams that either make up a rigid moment-resisting frame system or are concentrically or eccentrically braced. Floor and roof diaphragms are typically composed of metal decking with concrete fill or cast-in-place concrete slabs. Exterior walls can be any of several types such as metal, precast concrete panel, or brick masonry. Gravity load are carried by the columns, and lateral earthquake forces are carried by the steel frame. This type of construction is not common in New Zealand, and is mostly low-rise.

Construction Type 26: Buildings that are constructed of light steel framing. These are typically long narrow one story buildings, having no interior columns, that are on a reinforced concrete floor. The framing consists of steel portal frames in the transverse (short) building direction, with diagonal tie rods in the longitudinal (long) building direction. The wall and roof claddings are typically corrugated iron, fibreglass, or asbestos. Gravity loads are carried by the columns, and lateral earthquake forces are resisted by rigid moment-resisting frame action in the transverse direction and by the diagonal tie-rods in the longitudinal direction. This type of construction is common in New Zealand for industrial occupancies.

Construction Type 32: Buildings with walls constructed of 2x4" wood studs spaced at 24" covered on the outside with a variety of cladding materials. Starting with the most common the external claddding materials are timber weatherboards, brick veneer, stucco or corrugated iron. Interior cladding is nearly always gypsum board. Floors may be timber or reinforced concrete slab. The roof framing is usually timber, and the cladding may be a variety of materials including corrugated iron, clay tiles, concrete tiles, or pressed sheet metal tiles. Gravity loads are carried by the walls in compression and lateral earthquake forces are resisted by the walls in shear. This is by far the most common form of residential construction in New Zealand. Well constructed buildings of this type are typically highly resistant to collapse because of the toughness of the walls and the light weight of the superstructure.

Construction Type 34: Buildings having perimeter walls made of large single-height reinforced concrete panels that are tilted up into wall position. The wall units are then anchored to the foundation and are inter-connected. The floor is reinforced concrete, and the roof system may be steel or timber truss, or steel portal frame. Roof cladding is usually corrugated iron. If the building has a large foot print, there may be intermediate columns between the walls to support interior gravity loads. Gravity loads are resisted by the tilt-up walls and any intermediate columns. Lateral earthquake loads are resisted by the shear-wall action of the tilt-up walls, and portal frames if present. Tilt-up buildings are typically one story. Tilt-up buildings are most commonly used for industrial and commercial occupancies.

NOTES FOR PART 2:

The occupancy fractions for New Zealand are to be interpreted as follows: "LIVES" means occupancy at night, and "WORKS" means occupancy during a normal working day. For example, the number 0.919 for column "urban areas (4)", row "WHE Construction Type" 32, means that of the total number of people who are indoors at night-time, 91.9% are in buildings of Type 32. The final row labelled "All Classes" contains the estimated total numbers of occupants for each of the four categories LIVES urban, LIVES rural, WORKS urban and WORKS rural. I have no data and no models for the final column "Peak average number of occupants per building". Indeed I am unsure what to provide, because the day and night occupancy rates are completely different, for all construction types. The estimated total population is 4.228 million, of whom 99% are assumed to be indoors at night-time and 80% indoors during the working day.