SEISMIC CLASSIFICATION SYSTEM FOR OLD BUILDINGS IN NEW ZEALAND

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SYNOPSIS

In New Zealand there are a large number of public buildings designed prior to the introduction of a seismic design code in 1935. These buildings constitute an earthquake hazard and must be replaced. To this end the Ministry of Works have developed a classification system which allows for a systematic replacement of these buildings, in accordance with the magnitude of the hazard.

In view of the large number of buildings involved in relation to the available survey teams, the system had to be simple. Uncertainties in the evaluation of old buildings in any case do not justify a highly theoretical and complex approach.

1. Basis for Replacement

To establish a basis for the period of maximum life expectancy a period of 60 years was used. For normal loan purposes the Government Loans Board assumes a maximum life expectancy for buildings of 35 years although the probable period of occupancy may be as much as 100 years. For the purposes of this survey a maximum period of 60 years for new buildings was considered to be appropriate.

On this basis it was decided that the maximum period for replacement of these non seismic resistant buildings should be 30 years or half the life of a new building. New Zealand is divided into three seismic zones and there are two types of occupancy risk, e.g., offices and the like are considered to be less of a risk than schools and hospitals. Within each zone a further six grades are arranged in order of estimated seismic resistance.

A summary of the suggested replacement period for various classes of buildings in their respective zones is contained in paragraph 3.

2. Classification System

2.1 Classification according to principal material of construction

Buildings are first classified according to the principal material of construction as follows:

(1) Structural steel frame (short reference "S").

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(2) Reinforced concrete frame or reinforced concrete floors and walls, (short reference "R").

(3) Masonry walls, (short reference "M").

(4) Wood framed buildings, (short reference "W").

(5) Other types (short reference "O").

2.2 Classification according to hazard

Class A. Buildings regardless of materials of construction which should be evacuated immediately because they constitute a potential hazard in the event of windstorm or mild to moderate earthquake or because of hazard in normal occupancy arising from poor condition or other adequate reason.

Class B(i). (a) Buildings which have particular hazards such as chimneys, parapets and gables liable to damage in the event of an earthquake, floors requiring load reduction, propping or complete removal, exitways requiring improvement or duplication, and floors, walls or roofs requiring additional sarking or bracing.

Class B(i). (b) Buildings with concrete floors supported on unreinforced masonry walls.

Generally the total cost of removing hazards and renovating should not exceed one third current costs of comparable new buildings.

Class B(ii). Buildings of steel or concrete which can be strengthend at reasonable costs to a standard adequate for intensities not less than one half of those specified in the loading part of New Zealand Standard Specification 1900. In general the total of strengthening and renovation costs should not exceed one third current costs of new structures.

Class B(i) buildings on removal of hazards and B(ii) on completion of strengthening measures shall be reclassified into one of the divisions of Class C.

Class C. This class comprises all non-earthquake resistant buildings not qualifying for immediate evacuation and not requiring remedial attention.

As most old buildings fall into this class it should be subdivided into five sections of approximately equal value and numbered from 1 to 5 in order of decreasing risk. To ensure uniformity in sub-classification the system of penalties shown in the Appendix Table I should be applied to each building according to condition, number of stories, effectiveness of framing and nature of the subsoil.

The total penalty should determine the appropriate subdivision of Class C. Thus buildings with the greatest number of penalties are classified C.1 and the least number C.5. Should it prove necessary to discriminate further between buildings with the same total penalty account may be taken of other significant factors such as:

Importance to the community.

The number of people inside and outside the buildings likely to be affected by damage to the building.

Class D. This class comprises all earthquake resistant buildings which are free from hazard and in good condition.

3. Replacement Period

The programme for structurally upgrading buildings takes account of relative regional seismicity and occupational factors. For instance, buildings designed say for schools and hospitals should be treated with greater urgency than those in low seismicity regions or designed for use as offices. Although work programming is the responsibility of the client departments the proportion of the scale shown in the Appendix Table II seems reasonable for a replacement programme.

4. Independent Check

Classification involving action such as evacuation or demolition, removal of hazards or strengthening, that is, classification in groups A, B(i) and B(ii) are independently checked.

5. Survey Review

In general survey reviews are recommended at not longer intervals than one-quarter of the estimated "life" expectancy of the building but in any event not more than five years. During the period of the initial survey staff shortages have made it difficult to carry out survey reviews of all buildings. It seemed to be more important at this stage to complete the initial survey.

6. Survey Forms

Buildings other than timber. A copy of the form used for building survey work is shown in the Appendix Fig.I. The required information is fairly extensive so that a good appreciation of the building's seismic resistance can be obtained from the details supplied.

In addition plans and photographs of the building and particularly of any defects are generally supplied. This allows co-ordination of the programme by Head Office, Ministry of Works.

For timber buildings. A much simpler form is used (Appendix, Fig.2). In most cases timber buildings are demolished because of functional obsolescence rather than lack of seismic resistance. Brick and precast pumice chimneys have often constituted a seismic hazard. Tiled roofs have performed badly. Even in the better construction only every third tile is wired to the rafters. Heavy roofs, flexible pier foundations and lack of adequate ties between bearers and foundations contribute significantly to the seismic risk in timber buildings.

7. Programme for Survey Work

In order that reasonable progress should be made with the survey work a programme was drawn up aiming to complete the surveys within three years. After one year good progress has been made in four of the seven Ministry of Works Districts throughout the country but much less in the other three owing to staff shortages.

8. Buildings Surveyed

By the end of March 1968, a total of about 900 buildings have been surveyed. Of these, half are buildings designed before the introduction of a seismic code in 1935, and half have been completed since. The reason for including in the survey a large number of buildings that were constructed after 1935 is that schools are surveyed as a whole but comprise, as a rule, buildings of different ages including many built in recent years.

The buildings which historically have posed the largest earthquake risk are the pre 1935 unreinforced masonry buildings. So far 300 of these buildings have been surveyed. Demolition has been carried out on a number of buildings classified MA and MC1 and replacements are being planned for a number of others. In addition particular hazards have been demolished on a large number of buildings. These include more particularly brick chimneys, parapets, and unsupported masonry walls and end gables.

9. Strengthening Proposals

A number of major strengthening schemes are under way and particular emphasis is given to the requirements under B(i)(b) and B(ii) in paragraph

2.2. It should be noted that where the estimate for strengthening and renovation exceeds one third the cost of comparable new buildings the proposal is not recommended. It has been found that estimates for strengthening schemes are generally too low and that costs rise as further weaknesses are discovered when the work commences. Building services are also frequently found to be in need of repair. Although a strengthening cost of one third the cost of replacement is generally considered to be a reasonable economic proposition higher expenditures may be warranted when there is a shortage of capital for new buildings. Naturally, each proposal must be dealt with on its merits, particularly in the case of major buildings where alternative accommodation would have to be found for large numbers of tenants.

10. Conclusion

The classification system for non seismic resistant buildings presented has been found to be efficient in practice. Priorities for the replacement of the buildings can be established and the forward planning for the construction of new buildings formulated accordingly. The period for replacement of buildings in their various classes, is relative only and is subject to financial considerations.

11. Acknowledgments

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	Penalties		
	0	1	2
1. Structural* condition	Good	Fair	Bad
2. Number of stores above ground	One	Two to four	More than four
3. Type of framing (effective vertical and horizontal diaphragms)	Fully effective	Partly effective	Non effective
4. Bearing pressure of subsoil.	More than 1 ton/sq.ft.	$\frac{1}{2}$-1 ton/sq.ft.	Less than $\frac{1}{2}$ ton/sq.ft.

*Additional penalties are to be applied to buildings damaged by earthquakes.

TABLE I

No. of Demerits	Classification	Zone A		Zone B		Zone C	
		Hospitals Schools Assembly Buildings Years	Offices Workshops etc. Years	Hospitals Schools Assembly Buildings Years	Offices Workshops etc. Years	Hospitals Schools Assembly Buildings Years	Offices Workshops etc. Years
	A	0-2	0-3	0-3	0-4	0-4	0-5
8 7	C1	2-4	3-6	3-6	4-8	4-8	5-10
6 5	C2	4-6	6-9	6-9	8-12	8-12	10-15
4 3	C3	6-8	9-12	9-12	12-16	12-16	15-20
2 1	C4	8-10	12-15	12-15	16-20	16-20	20-25
0	C5	10-12	15-18	15-18	20-24	20-24	25-30

TABLE II

Suggested replacement period

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BUILDING SURVEY

DATE: | REPORT No: | FILES:

NAME AND ADDRESS

Name of Building: .....
Street: ..... No.: .....
Locality: .....

Control Dept.
Seismic Zone: .....

D.O.: .....
H.O.: .....
Other: .....

OWNERSHIP

Govt. owned: ..... Leased: ..... Area: .....

USED AS

Hospital, Mental Hospital, Prison Office, Telephone Exchange, Storage Building, Nurses' Home or Hostel, Laboratory, Garage, School, Other: .....

DESIGNER

Original – H.O.: ..... D.O.: ..... Other: ..... Date: .....
Additions – H.O.: ..... D.O.: ..... Other: ..... Date: .....

PLANS, ETC.

Original – H.O.: ..... D.O.: ..... Other: ..... Photos: .....
Additional – H.O.: ..... D.O.: ..... Other: ..... Photos: .....

STRUCTURE

No. of Storeys: ..... Mezz.: ..... Basement: .....
Building Dimensions: Width: ..... Length: ..... Height: .....
Foundation Type: Strip footing: ..... Raft: ..... Column pads: .....
Piles: ..... Caissons: .....
Ground Conditions: Rock: ..... Gravel: ..... Sand: ..... Silt: ..... Clay: ..... Fill: .....
Frame. Steel: ..... R.C.: ..... Wood: ..... Other: ..... Full: ..... Partial: .....
Exterior Panels: R.C.: ..... Brick: ..... Wood: ..... Other: .....
Exterior Wall Veneers: Brick: ..... Stone: ..... Precast: ..... Curtain: ..... Other: .....
Remarks: ..... Condition: .....
Bearing Wall: R.C.: ..... Brick: ..... Wood: ..... Other: .....
Masonry wall bands: .....
Floors R.C.: ..... Wood: .....Other: ..... Effective diaphr.: ..... Non-eff.: .....
Roof: Pitched: ..... Flat: ..... Other: .....

SKETCH

Roof Framed:	*Wood*	*Steel*	*Concrete*
Rigid Frame			
Simply Supp. Truss			
Kneebraced Truss			
Other			

Roof Diaphragm: Concrete: ..... Steel: ..... Wood: ..... Other: .....
Effective: ..... Non-effective: .....
Roof Coverings: Concrete slab: ..... Asphalt: ..... Galvd. iron: .....
Corr. Asbestos: ..... Tiles: ..... Other: .....
Chimneys: Brick: ..... R.C.: ..... Steel: ..... Remarks: .....

	Where	*Material*	*Height*	*Width*	*Thickness*	*Remarks, Condition*
Parapets						
Gables						
Heavy Ornaments						

Lifts: Number: ..... Open: ..... Enclosed: .....
Stairs: Number: .....Type: ..... Wood: ..... Steel: ..... R.C.: .....

NON STRUCTURAL

Partitions: R.C.: ..... Brick: ..... Breeze: ..... Conc. Block: .....
Wood: ..... Other: ..... Condition: .....
Ceilings: Lath: ..... Wood: ..... Fib. plaster: .....
Other: ..... Condition: .....

DAMAGE

Cracked walls: ..... Joints: ..... Displacement: .....
Settlement: ..... Photos: ..... Remarks: .....

ADDED BANDS OR TIES OR OTHER RFCT.

Description:

STRUCTURAL CONDITIONS OF BUILDING

Overall: ..... Poor: ..... Good: ..... Excellent: .....
Hazards: .....
Remarks:

FIGURE 1.

BUILDING SURVEY – *continued*

DISTRICT STRUCTURAL ENGINEER'S COMMENTS

PREVIOUS REPORTS –

Date	*D.O. File*	*Action*	*Prepared By*

STRUCTURAL ASSESSMENT –

Principal Framing Material –

Structural steel frame 'S'
Reinforced concrete 'R'
Other type 'O'
Masonry walls 'M'
Wood framed 'W'

Building Class A –

Buildings which should be reviewed in not more than six months.

Evacuated within ..... months.

Building Class B (Classification review in not more than one year) –

(i) (a) Building requiring attention to particular hazards as under:
Chimneys, Parapets, Gables, Exitways, Floor props, Load removal, Add. bracing, Floor removal, Tying floor, Diagonal marked partitions, Other.

(b) Masonry buildings with concrete floors requiring strengthening in the following manner:

(ii) Buildings of structural steel or concrete requiring strengthening in the following manner.

Building Class C (Classification review in one to five years depending on classification sub-division) –

Division (i) (ii) (iii) (iv) (v).

Building Class D (Designed to be earthquake resistant – classification review not less than five years) –

Other Buildings –

Classification: ..... Suggested Replacement Period: ..... (Base Year 1965) Date of Review: .....

Inspector: ..... Classifier: .....

D.O. Comments:

H.O. Comments –

H.O. Files: 24/156 Buildings General
31/1155/9 Schools General
Parts: /2 Dunedin; /4 Auckland; /8 Wanganui; /10 Napier; /11 Wellington; /15 Christchurch; /18 Hamilton.

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FIGURE 1(a).

BUILDING SURVEY

TIMBER BUILDINGS

REPORT No.....

FILES: .....

Address and Name:	School:	Education Board: .....
.....	Block:	M.O.W. D.O.: .....
.....	Street:.....	M.O.W. H.O.: .....
.....	Locality:	Other: .....

Plans:	Photos: .....
Date of Construction:	Date of Additions: .....
Number of Storeys:	Upper Floor Construction: .....

Dimensions - Width: ..... Length: ..... Height: .....

Foundation Type: .....

Framing - Cottage Type: ..... Exterior Bearing Walls Only: .....

Portals: ..... Other: .....

Roof - Pitched: ..... Flat: .....Other: .....

General Condition of Timber: ..... Any Evidence of Settlement: .....

Structural Condition - Poor: ..... Fair: ..... Good: ..... Excellent: .....

Suggested Replacement Period:	Classification: .....
D.O. Comments:	H.O. Comments: .....
.....	.....
Education Board Inspector:	M.O.W. Classifier: .....

FIGURE 2.

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