A TENTATIVE METHOD FOR RECORDING AND ANALYSING SEISMIC DAMAGES IN ONE STORY DWELLINGS

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ABSTRACT

A method for recording, categorizing and investigating the probable causes of the seismic damages in one-story dwellings is presented. The method was developed to investigate the behaviour of typically designed dwellings repeatedly built in many large housing developments in Chile. The buildings in brokendown into its components parts. The grade of seismic damage for the structural members and buildings is evaluated according preestablished scales of damages. The determination of the more probable causes of the damages is obtained by comparing the patterns of the registered damages with typical damages produced by preestablished factors. The information collected permits to take decisions on whether to leave the dwelling in its past-earthquake condition, repair or demolish; also whather to revise the existing designs to avoid similar damages in the future.

1.0 OBJECTIVES AND SCOPE OF THE METHOD.

The main objectives of the method are:

1.1 Obtaining of a systematic recording of the seismic damages.
1.2 Categorizing of damages to buildings and groups of similar buildings.
1.3 Determination of the more probable causes of the damage.

The method has been developed for the type of construction usually employed in Chile, which has had some degree of seismic design. All the information about the design and construction of the dwellings must be available and, finally, the dwellings must be in a condition which permits inspection after the earthquake.

The results obtained by this method are of a qualitative nature.

2.0 FUNDAMENTALS OF THE METHOD.

2.1 Breakdown of the Building.

A low-cost dwelling is composed by a group of interdependent systems: the structural system, the service systems (water supply and plumbing, lighting, ventilating, wastes, etc.) and the non-structural systems (partitions, flooring, ceiling, insulations, waterproofing, soundproofing, etc.). Each of these systems is constituted by members, joints and materials; some of the members can be subdivided in component units.

The structural system includes members such as walls, columns, beams, girders, etc. A masonry wall is made up of units-bricks or concrete blocks-and mortar joints constituted by materials-cement, sand, gravel, etc.

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To establish the gradation of the damage of a building the structural members are classified as follows:

2.1.1 Primary Structural Members: They are the essential members required to provide strength and stability to the building as a whole and they have been designed accordingly.

2.1.2 Additional Structural Members: These members were assumed to be secondary members in the design but they have behaved as primary members under earthquake loading.

2.1.3 Secondary Structural Members: They only support loading from their own weight and operating conditions. The failure of these members does not affect the basic structure.

2.2 Seismic Damage Scales.

To describe the grade of damage the followingscales have been used.

2.2.1 Damage Gradation in Structural Members:

0.-	Undamaged Member:	Member without any damage.
1.-	Fissured Member:	Member which has some fissures or clefts
2.-	Cracked Member:	Member having cracks which do not cover completely its length
3.-	Split Member:	Member with cracks which cover all of its length
4.-	Broken Member:	A member which has reached its rupture but maintains its position
5.-	Destroyed Member:	A member which shows hollows produced by the earthquake.
6.-	Wrecked Member:	A member that has been demolished or ruined by the earthquake.

Where:

Fissure: A narrow crack which does not cut through the member
Crack: A cleft which cuts through the member section presenting a gap up to 2 mm.
Rupture: A crack that cuts through the member presenting relative displacements of its faces and a gap larger than 2 mm.

2.2.2 Damage Gradation in Buildings Considering the Grade of Damage of its Primary Structural Members.

0.-	Undamaged Building:	A building without damages
1.-	Fissured Building:	A building with fissures and small cracks on its walls, columns or bond beams.
2.-	Cracked Building:	A builging with small cracks on the main walls up to splitting on some other walls.
3.-	Split Building:	A building with splitting in its main walls up to small ruptures on other walls
4.-	Broken Building:	A building with important ruptures up to small hollows on its members.
5.-	Destroyed Building:	A building with hollows on its main walls up to partial demolitions on other walls.
6.-	Wrecked Building:	A building with the majority of its walls demolished as consequence of the earthquake.

2.2.3 Estimate of the Damage of a Group of Buildings considering the Grade of Damage

$$D_G = \frac{1}{N} \sum_{0}^{6} D_i f_i$$

Where:

D_G = Grade of Damage of the group of buildings

D_i = "i" Grade of Damage for an individual building.

f_i = Frequency of D_i

N = Total number of buildings of the group.

2.3 Patterns of Damages Produced by the Earthquake.

By inspection of the records of damages of the buildings some patterns of damages for group of buildings can be obtained.

2.4 Preestablished Factors of the Damage.

To investigate the more probable causes of the damages one can define arbitrarily some factors which may have incidence in the damage. The factors used up to now in Chile for low-cost dwelling investigations habe been: The earthquake, the geology of the area, the soils of the site, the topography of the site, the design, the materials and the execution.

2.5 Typical Damages Produced by the Preestablished Factors.

Each of the preestablished factors can be associated with some typical effects determined experimentally or theoretically.

3.0 METHOD OF RECORDING.

3.1 Gathering of General Antecedents.

3.1.1 Geographical, geological, topographical and seismic antecedents of the region.
3.1.2 Antecedents of design and construction of the buildings.
3.1.3 Reconnaissance of the area to be analysed.

3.2 Recording of Damages.

3.2.1 Recording methods: forms, photographs, prospects, surveys, etc.
3.2.2 Personnel and material recourses.
3.2.3 Field work: obtaining and confirming the records.

3.3 Organize the Information obtained.

4.0 METHOD FOR THE ANALYSIS OF DAMAGE AND DETERMINATION OF THE CAUSES.

4.1 Categorizing and Gradation of the Damage.

The evolution of the damage of members, buildings and group of buildings is obtained by comparing the recorded damages with the scale of damages.

4.2 Analysis of the Causes of the Damages.

A preliminary analysis is made by comparing the patterns of damages determined from records with the typical damages associated with the preestablished factors.

From the results of the preliminary analysis a deeper investigation of are those factors that have appeared as the more probable causes of the damages can be developed. If necessary, some other factors not included in the preliminary analysis can be considered for further investigation.

4.3 Recommendations.

With the results of the preceding steps is possible, to formulate recommendations as to wheter repair, demolish or to leave dwelling in its postearthquake condi - tion.

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