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Vulnerability Assessment of Buildings in Vijayawada

[1]Parvataneni Bhargav [2]Bhargav Mantena [3]P. Venu Gopal [4]A. Vinod Kumar [5]Aparna Srivastav.K
[1][2][3][4] IV B.Tech.,Department Of Civil Engineering,
PVP Siddhartha Institute of Enginering and Technology, bhargavparvataneni

***Abstract:*— Vijayawada is one of the densely populated cities in India that is susceptible to earth quakes due to recent tremors occurred in the city .Vijayawada although falls in zone 3 of the seismic zonation of map of is 1893;2002 and is highly susceptible to earth quakes .Visual screening has been carried out for Reinforced concrete buildings in poranki, kanuru area in Vijayawada and a statistical analysis has been carried out of performance score using c programming .**

***Keywords:*----- Seismic vulnerability, Reinforced concrete buildings, Earthquake**

I. INTRODUCTION

The assessment of the structural vulnerability for existing buildings is a crucial aspect for the seismic risk reduction, in particular for strategic and important buildings because of their significance for the civil protection. The evaluation of the structural vulnerability is based on: empirical methods, analytical methods and hybrid methods. Vulnerability Index Method is calibrated on the survey of a large sample of different buildings, consists in filling in a survey form composed of a number of parameters: for each parameter, the surveyor has to give a judgment (four possibilities, from "A" - optimal condition to "D" - unfavorable condition), which allow a more objective decision. For each parameter, a numerical score value is given by the method. Using the weight coefficients related to each parameter it is possible to calculate a Vulnerability Index, (Iv), usually normalized in a 0%-100% range, where a low index means that the structure is not so vulnerable and therefore it has a high capacity under seismic action.

RCC Structure: Reinforced concrete, or RCC, is concrete that contains embedded steel bars, plates, or fibres that strengthen the material. The capability to carry loads by these materials is magnified, and because of this RCC is used extensively in all construction. In fact, it has become the most commonly utilized construction material. Reinforced materials are embedded in the concrete in such a way that the two materials resist the applied forces together. The compressive strength of concrete and the tensile strength of steel form a strong bond to resist these stresses over a long span.

***Vulnerability Index Method*:**

The method consists in attributing a numerical value to each building representing its "seismic quality". This number is called vulnerability index; it is obtained by summing the numerical values expressing the "seismic quality" of the structural and non structural parameters which are deemed to play a significant role in the seismic response of the building

The parameters' coefficients are determined on a basis of a statistical data containing constructions damaged by different earthquakes. The considered parameter can take only one factor. For RC buildings, each parameter considered can belong to one of the three defined classes A, B, C, &D.

Objective:

The major objective of this work is

- To assess vulnerability of existing structures against probable earthquake.

II. LITERATURE REVIEW

***Empirical Method*:**

Among the approaches classified as empirical methods, the Vulnerability Index Method (or VIM; Benedetti et al, 1988), is widely used to assess buildings and applications of this method are numerous (Oliveira et al, 2005; Barbat et al, 2008; Vicente et al, 2014). This approach is based on estimating the vulnerability of masonry buildings by calculating a vulnerability index (Iv) as the summation of weighted parameters associated with the structural features of the building typology, which have been observed to affect their seismic response. Data on the constructional properties of the building is required for the definition of Iv, while damage data from past earthquakes is used for the calibration of the vulnerability functions. By relating Iv to the observed global damage levels for a

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building typology with reference to macro seismic intensity levels, the Iv can be applied to regions characterised by the same building typologies and same level of macro seismic intensity or peak ground acceleration (Lagomarsino and Giovinazzi, 2006).

Guagenti and Petrini,1989,The data needed for the vulnerability assessment of residential buildings in Catania have been gathered in the field using simplified forms, through an extensive and quick survey. The simplified forms were obtained from the classical GNDT 1st and 2nd level (Benedetti and Petrini, 1984) forms that were used in this project for public buildings(GNDT 1996 version). Two simplified forms have been set up, one for masonry the other for R/C buildings, and containing 19 and 17 entries respectively. An overall damage assessment is carried out in an indirect way (Benedetti and Petrini, 1984): first a vulnerability index is determined on the basis of the data gathered from the survey, and then a relationship is used among vulnerability index, expected damage and horizontal peak ground acceleration

Dr. Massimiliano Pittore Prof. Dr. Stefano Parolai, 2016, with the term 'vulnerability' we refer to the susceptibility of the considered assets of being damaged by the strong shaking generated by earthquakes. Some buildings for instance can withstand a strong mechanical stress, while others might collapse with a relatively weaker shaking. The exposure and vulnerability information mentioned above are of paramount importance in order to provide a quantitative assessment of the resulting seismic risk in Kyrgyzstan. The data about population, total amount and composition, has been released by the Kyrgyz Statistical Office and have an early 2015 vintage.

Scope of work:

Vulnerability Index Method is calibrated on the survey of a large sample of different buildings, consists in filling in a survey form composed of a number of parameters: for each parameter, the surveyor has to give a judgement (four possibilities, from "A" - optimal condition to "D" - unfavorable condition), which allow a more objective decision. For each judgment of each parameter, a numerical score value is given by the method. Using the weight coefficients related to each parameter (provided in order to take into account the relative importance of each parameter in the global definition of vulnerability), it is possible to calculate a Vulnerability Index, (Iv), usually normalized in a 0%-100% range, where a low index means that the structure is not so vulnerable and therefore it has a high capacity under seismic action. Identifying the most vulnerable areas within a city/region or prepare ground work for more detailed future vulnerability assessment by different parameters is the need of the hour. It is intended to carry out this job for different types of buildings viz. Masonry buildings, RC framed buildings and RC framed with masonry integral buildings.

III METHODOLOGY

Brief Description of The Parameters For TheRCC with masonry infill Structure

Parameter 1 - Type And Organization Of The Resistant System

In this parameter, the building's organization and resistance system are evaluated, particularly based on the ductility/fragility of the elements of the structure.
There are three different behaviors which correspond to the three different classes:

- Rigid structure (due to the presence of consistent shear concrete walls); it is possible to consider a maintenance of the resistant characteristics even after a strong seismic event;
- Rigid-fragile structures with ductility resources (after the collapse of the most rigid elements, the structure starts to behave in a ductile way with more deformability because of the presence of a structural frame with seismic design);
- Rigid-fragile structures, with high stiffness/resistance decay after the seismic event, due to the absence of ductile elements in the structure.

Parameter 2 - Quality Of The Resistant System

In this parameter, mainly three aspects are evaluated: the type of materials (cement, sand, reinforcement, brick, concrete) and quality of the materials (mix design and grade of concrete), the characteristics of the realization of the structure (modes of oscillation, damping) and the principles of design of the building (reduced mass, symmetry and continuity of construction, strength and over strength and ductility of structure).

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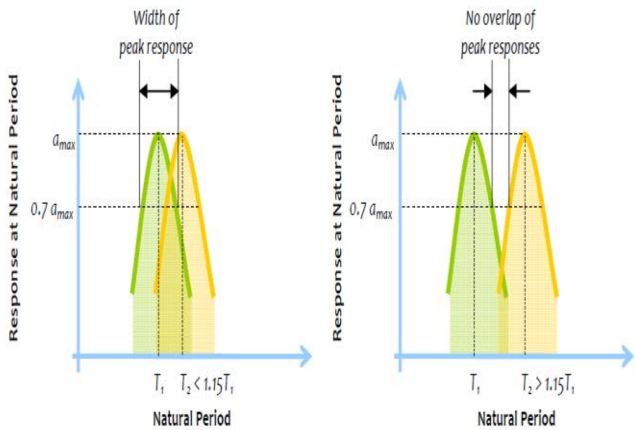
This information can be obtained from the original documents of the design of the structure, or directly by visual inspection when possible.



Proximity of Natural Modes: Combined Response of two adjacent modes should be avoided

Parameter 3 - Conventional Resistance

The resistance of a building under seismic actions can be evaluated (in a simplified way as proposed in euro codes) with an equivalent linear static analysis with no eccentricities and planimetric irregularities; it is necessary to evaluate the ratio between the shear resistance (sum of the cross-sectional area of all the columns multiplied for the shear strength) and the seismic forces derived from the simplified analysis. In this way, it is possible to calculate the multiplier α which gives information about the ratio "capacity/demand" in terms of shear forces, and consequently the judgment to assign to the structure.

Parameter 4 - Position Of The Building And Foundations

In this parameter, the type of foundations is taken into account. In particular, it is important to observe the type of the soil and the presence of different level of foundations.

Parameter 5 - Typology Of Floors

As seen for masonry structures, two main aspects must be taken into account: the stiffness of the floor in its plane and the presence of good connections of the floor with the vertical elements.

Parameter 6 - Planimetric Configuration

The planimetric configuration of the building is here analyzed, in order to evaluate its regularity. Four aspects must be considered: the distribution of masses, Horizontal irregularity Plan Aspect Ratio and the planimetric shape of the building.

Parameter 7 - Elevation Configuration

The distribution of stiffness and masses along the height of the structure is here investigate: a limited reduction of stiffness connected to higher levels is accepted (due to the dynamic response of the system) while the increase of masses or stiffness at higher levels must be penalized, since they lead to a worse dynamic behavior.

Parameter 8 - Connections And Critical Elements

In this parameter, it is important to observe the connections among structural elements (beam-column, floor/beams, foundation-columns...). For the analysis of this parameter, some geometrical rules are contained in the Handbook of the Vulnerability Form.

Parameter 9 - Low Ductility Elements

The possible presence of elements with a fragile behaviour is here highlighted.

Parameter 10 - Non Structural Elements

In this parameter, the presence of elements (without a structural function) which can cause damages to persons or objects due to their fall is analyzed.

Parameter 11 - State Of Conservation

The current condition of the building is here analyzed. It is important to pay attention to all the structural elements (columns, beams, floors) at first, then to foundations and non-structural elements.

Parameter 12 - Climatic Conditions Where The Building Is

In this parameter mainly four things are taken in to account they are Temperature Zone, Rain Fall Intensity, Wind Intensity, Earthquake Zone based on the consideration of zoning the building can be analyzed. For reinforced concrete structures there are no specific weights for each parameter: each of them has the same importance in the calculation of the global Index of Vulnerability. For reinforced concrete structures there are no specific weights for each parameter each of them has the same importance in the calculation of the global Index of Vulnerability.

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The Index of Vulnerability is obtained as the sum of the scores of each parameter:

$I_v = \sum_{i=1}^{12}(V_i)$

Where

V_i: are the scores of Vulnerability of each parameter.

***Seismic Vulnerability Assessment Procedure*:**

The seismic vulnerability assessment procedure has been summarized in the following ways:

STEP 1: Site investigation.
STEP 2: Walk down Survey & Evaluation.
STEP 3: calculation of building seismic scores.
STEP 4: classification according to building scores
STEP 5: identifying various elements of building.
STEP 6: selection of basic estimation parameters
STEP 7: finding out vulnerability index.
STEP 8: estimating the scale in which vulnerability index value come under.

Study Area

Fig 1: Study Area: Kanuru, Vijayawada.

IV RRSULTS AND DISCUSSIONS

PARAMETERS	rigid-fragile structures with high stiffness/ resistance decay after the seismic event				
	1	2	3	4	5
Parameter 1	0.00	0.00	0.07	0.00	0.00
Parameter 2	0.07	0.07	0.07	0.07	0.07
Parameter 3	0.00	0.01	0.00	0.00	0.00
Parameter 4	0.12	0.12	0.12	0.12	0.12
Parameter 5	0.10	0.10	0.10	0.10	0.10
Parameter 6	0.10	0.10	0.09	0.09	0.09
Parameter 7	0.00	0.00	0.00	0.00	0.00
Parameter 8	0.20	0.20	0.10	0.20	0.10
Parameter 9	0.00	0.00	0.00	0.00	0.00
Parameter 10	0.06	0.06	0.06	0.06	0.05
Parameter 11	0.25	0.25	0.25	0.25	0.25
Parameter 12	0.12	0.12	0.12	0.12	0.12
Total P_i values	1.04	1.04	0.93	1.03	0.91
Total vulnerability %	41	41	39	41	39

V. CONCLUSIONS

1. All the buildings in the study area are regid and fragile structures so the type and organization of the resistant system is good.
2. The Quality of the resistant system is also in good condition.

3. All the lateral and longitudinal baring capacity of building are calculated for the load to be bared, the Conventional resistance is also very good.
4. The position of the building and foundations are also laid good due to the black cotton soil pile foundation is adopted for every building.
5. While Connections and critical elements are considered special care should be taken while construction.

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