

Rapid Visual Screening of RC frame buildings in 2001 Bhuj earthquake affected Rambaug area of Ahmedabad, Gujarat

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ABSTRACT

The buildings in Ahmedabad experienced heavy damage in the 2001 Bhuj earthquake, which exposed the deficiencies in their design and construction practices. The enhanced seismicity in the region warrants assessment of seismic vulnerability to aid engineers in urban development. The current study attempts to assess the vulnerability of RC frame buildings using Rapid Visual Screening (RVS) in the Rambaug area (Ahmedabad) where the collapses of a similar type of buildings were observed due to 2001 Bhuj earthquake. The RVS of 100 RC frame buildings was conducted. The performance score of the surveyed building ranges from 20 to 125. The parameters such as soft storey and overhang are found in most of the surveyed buildings, which make the buildings vulnerable to earthquake. The vulnerability here is defined as a relative measure based on the obtained performance score of the considered buildings. Most of the buildings lay in the performance score range of 43-84, which indicates moderate vulnerability of these buildings due to earthquake occurrence.

Keywords: Earthquake, Vulnerability assessment, Rapid visual screening.

INTRODUCTION

In recent times, a number of damaging earthquakes have been experienced in our country that include Bhuj earthquake (2001), North Andaman (2002), North Kashmir (2005) and Sikkim earthquake (2006), which demonstrated the high seismic hazard leading to huge loss of life and economy. Rampant construction, coupled with improper implementation or planning in urban areas, led to substantial losses during 2001 earthquake while putting the safety of the people at stake. The occurrence of many other damaging earthquakes following the 2001 Bhuj earthquake has put further seismic safety as a big concern to the seismologist as well as the government. The estimated losses according to the Gujarat government was Rs. 10,000 crores and death figure were 13,805 in Gujarat during the 2001 Bhuj earthquake. (Mishra, 2012).

In fact, the city of Ahmedabad, a major city located 250 km from the epicenter, has also suffered huge losses in terms of life and property in the 2001 Bhuj earthquake. It is highlighted by Mishra (2012) that 80 buildings that collapsed in Ahmedabad were mostly of more than 3 storeys and were constructed within the last thirty years. Ahmedabad being the fastest growing city in Gujarat, where the population is on the rise and the infrastructural development is continuous past earthquake experiences suggests that buildings in the city are vulnerable to future earthquakes, highlighting the need to assess the seismic vulnerability of buildings in Ahmedabad.

SEISMIC VULNERABILITY

Seismic vulnerability of a building is highly dependent on the structural properties and soil type. Seismic vulnerability assessment is a two-step procedure, (i) preliminary analysis, and (ii) detailed analysis. In the preliminary analysis, rapid visual screening and collection of structural drawings are to be done. In the detailed analysis, linear or nonlinear analysis of the buildings needs to be performed based on collected structural drawings.

Rapid Visual Screening (RVS) was developed by the Applied Technology Council (ATC) and was first published by the Federal Emergency Management Agency (FEMA) in 1988. This method uses to screen buildings based on visually observable vulnerability parameters of the building. Based on these observed vulnerability parameters, expected performance score of the building to be calculated which indicates its adequacy against earthquakes. RVS does not require the screener to perform any structural calculations but only needs to identify the type of building and its attributes that affect the performance of the structure against seismic forces. Dutta et al., (2016) have carried out the damage survey for the RBI properties in Patna after Gorkha (M 7.8) earthquake (April 25, 2015). It puts forward an attempt to validate a RVS method for non-engineered structures and highlights the need and the importance of such quick assessment technique that will be helpful in assessing the vulnerability of large region and mitigation process in an event of earthquake.

Table 1. Considered vulnerability parameters in different vulnerability assessment method for RC structure.

Vulnerability assessment method	FEMA, 2015	Sucuoglu et al., 2003	Jain et al., 2010	Arya, 2000	Srikanth et al., 2010
Soft storey	Y	Y	Y	N.G.	Y
Heavy overhang	Y	Y	N	N.G.	Y
Short column	Y	Y	Y	N.G.	Y
Pounding possibility	Y	Y	N	N.G.	Y
Age of the structure	Y	N	N	N.G.	N.G.
Building height	Y	Y	Y	N.G.	Y
Maintenance	Y	N	Y	N	Y
Apparent quality	Y	Y	Y	N	Y
Re-entrant corner	Y	N	Y	N.G.	Y
Basement	N. G.	N	Y	N	Y
Soil type	Y	Y	Y	N.G.	Y
Topographic effect	Y	Y	N	N	Y
Vertical Irregularity	Y	-	-	N.G.	Y
Plan irregularity	Y	-	-	N.G.	Y

*Y: Yes; N: No; N.G.: Not graded

Different RVS methods available among several countries are USA (FEMA, 2015), Canada (NRCC, 1993), New Zealand (NZSEE, 2006), Japan (JBDPA, 2001), and Turkish RVS (Sucuoglu et al., 2007). The researchers (Nanda and Majhi, 2013) have done a brief review and comparison of some of the RVS methods among several countries.

FEMA recently revised its RVS method in 2015 (FEMA, 2015), which is much detailed and consistent with the current building typologies in the US. It addresses the problem of the negative scoring observed in the earlier version (FEMA, 2002). The score in the RVS form have been derived using capacity spectrum method, but since they were derived for US building typologies and considering their soil conditions, this method cannot be directly applied to other regions and would require calibration to adopt the same in different regions as suggested by the available literature.

Jain et al., (2010) proposed an RVS method for RC-frame buildings using statistical analysis of post-earthquake damage data of 2001 Bhuj earthquake. A mean error of 20% in accurately predicting damage category was observed for the 1000 bootstrap samples considered for comparison between Expected Performance Score and Observed Performance Score but this method was based on limited data from damages in one Indian city and for one building typology. Further research on the same was recommended. A RVS procedure was proposed by Chanu and Nanda (2018) based on the Multivariable regression analysis performed on damage data of RC buildings during Manipur (M 6.7) earthquake (January 4 2016). Further, Arya (2000), proposed RVS Method for RC and Masonry structures, utilizing the damageability-grading system. It considers various building

typologies and relevant vulnerability parameters. However, for grading of the structures, the vulnerability parameters show no influence on the final grade, as the grading is based on the observed damage of past earthquake for the considered building type and the seismic zone in which the building lies. This, in turn, may not be enough to accurately predict the vulnerability of the structure due to the earthquake.

Sucuoglu et al., (2003) attempted to evaluate several selected parameters simultaneously to obtain a performance score for each building rather than a group of buildings as done in FEMA and other methods for 3-6 storey substandard concrete buildings. This score separates each building from the other buildings in the inventory in risk classification. Only 4 parameters were considered for vulnerability classification in the revised version (Sucuoglu et al., 2007) namely, the number of stories, the presence of a soft storey, the presence of heavy overhangs, and apparent building quality. Other parameters were dropped from the revised version, as they were not found to be significantly affecting the performance of the buildings in their study area. Srikanth et al., (2010) also proposed another RVS method which has been used in Gandhidham and Adipur cities, Kachchh, Gujarat in 2010 and a slightly modified version was used to survey buildings of Himachal Pradesh (Kumar et al., 2017). They have used Jain et al., (2010) and the Turkish method as a reference to develop the base score and score modifiers. Some additional vulnerability parameters were added, and their scores may be based on engineering judgment, as the basis of these scores is not explained in detail in the available literature. A tabulated format for comparison between different vulnerability assessment methods is given in table 1.

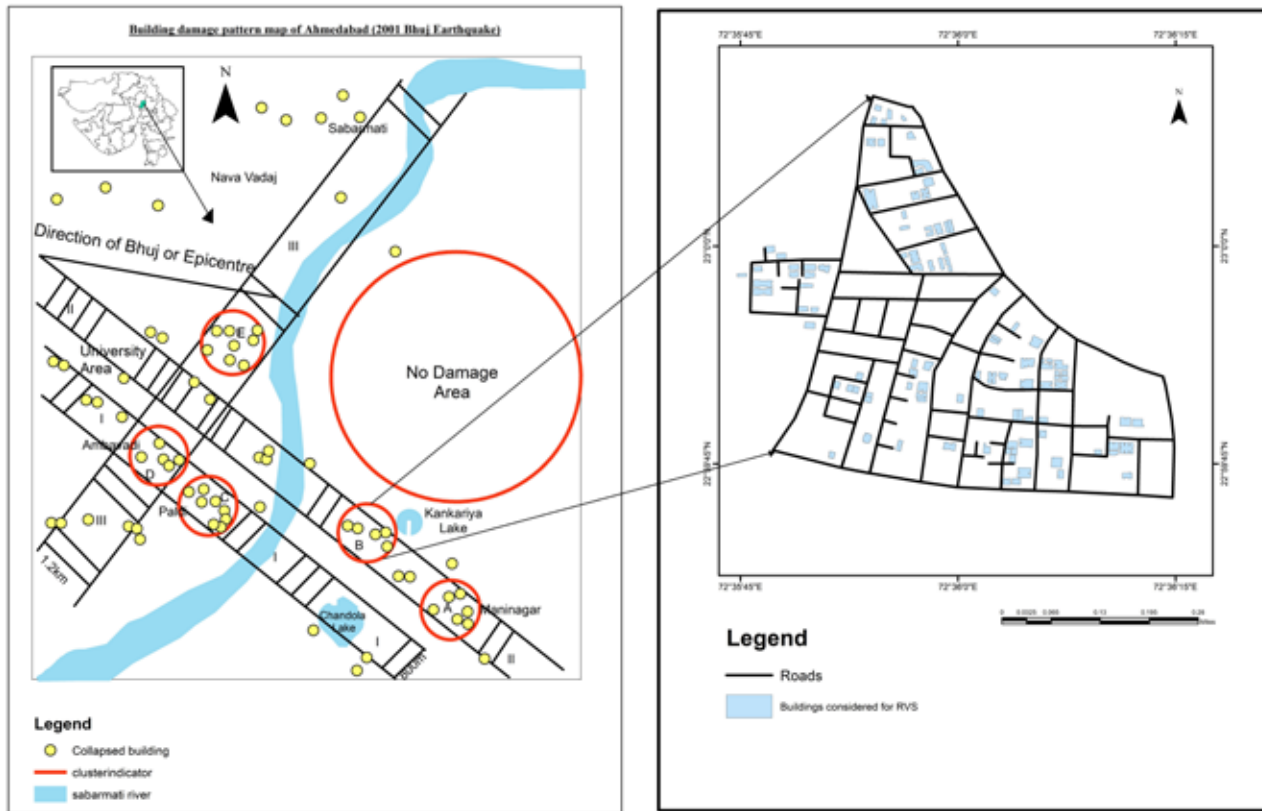


Figure 1. Location of Study area.

STUDY AREA

Based on the effects of 2001 Bhuj earthquake on the different types of buildings in Ahmedabad city, Jain et al., (2002) reported that 2 out of approximately 1500 RC frame buildings (of around 10 stories) and ~130 buildings out of approximately 25000 RC frame buildings (5 stories) had collapsed in Ahmedabad. Figure 1 shows the building collapse pattern map of Ahmedabad city during the 2001 Bhuj earthquake (Bhandari and Sharma, 2001). In their map, a group of collapsed buildings in close proximity has been encircled indicating areas of heavy damage in the city. Previous studies (Ghosh, 2001 and Mathur et al., 2005) have indicated that the area surrounding Kankariya Lake has shown the presence of soft soil condition, which may have contributed to the building damages in the area as observed in cluster “B” near Kankariya Lake (Figure 1). From available literature and with the help of local residents, 18 buildings that collapsed in the South zone of Ahmedabad during the 2001 Bhuj earthquake, were located on the ground. A cluster of six buildings was found in Rambaug area of Maninagar, which nearly aligns with cluster B shown in Figure 1a. Hence, the buildings in the Rambaug area has been considered for the RVS.

Determination of soil type is a major factor in the data collection form. The soil type for the study area is determined based on Mathur et al., (2005) that the area falls in zone D, which is the most hazardous zone having the Standard penetration N-value less than 10 and had suffered maximum damage during 2001 Bhuj earthquake. Hence based on the standard penetration N-value soil type 3 was considered as per IS 1893 Part I, (2016).

METHODOLOGY

Randomly selected 100 RC frame buildings of Rambaug area are considered for this study because similar RC frame buildings had collapsed and suffered heavy damage in the 2001 Bhuj earthquake. RVS on all selected 100 buildings has been carried out based on the form proposed by Srikanth et al., (2010). The RVS form Performa is shown in Figure 2. Information about the building identity such as the building type, address, use, number of stories and if required photographs are gathered during the walk down survey for RVS.

The base score is evaluated based on the number of stories and seismic zone. The vulnerability score is evaluated based on the presence of vulnerability parameters

Rapid Visual Survey of RC frame buildings for Earthquake safety 33		Seismic zone			
		Zone V			
		Zone IV			
		Zone II and III		✓	
Address/Location- Modern Flat, Shrinagar Society, Bhairavnath road, Plat 27/2/C Maninagar, Ahmedabad, Gujarat 380008.					
Longitude -72.896835		Number of floors- 4-storey			
Latitude - 22.999450					
Use	Residential	Commercial	Mixed	Others	
	✓				
CHECKLIST OF OBSERVABLES	COMMENTS				
Soft storey Open parking at ground level Absence of partition walls at ground or any intermediate storey for shops or other commercial use Taller heights in ground or any other intermediate storey	Present at the ground Level for Parking				
Vertical Irregularities Presence of setback Building on slopy ground	Not Present				
Plan Irregularities Irregular plan configuration Re-entrant corners	Not Present				
Heavy Overhangs Moderate horizontal projections Substantial horizontal projections	Presence of moderate horizontal projections				
Apparent Quality Apparent quality of construction and materials Maintenance	Good				
Short Columns	Not Present				
Founding	Not Present				
Soil condition	Soft Soil				
Frame Action	Present				
Falling Hazards Non-structural elements such as elaborate parapets, AC unit grilles, elevation features.					
Pictures/Sketches-					
					

(a)

RAPID VISUAL SCREENING OF EARTHQUAKE SAFETY						CALCULATION SHEET RC FRAME		
Falling hazards Identifier 'F'	Stories	Seismic Zone			Base Score			
		V	IV	II-III				
Parapets/beadings/roof signs	1 or 2	100	130	150				
AC units/grillwork	✓ 3	90	120	140				
Elaborate parapets	4	75	100	120			120	
Heavy elevation features	5	65	85	100				
Heavy canopies	>5	60	80	90				
Substantial balconies								
Heavy cladding								
Structural glazing								
Vulnerability Score (VS)						Vulnerability Score Modifier (VSM)		
NUMBER OF STOREYS						VS×VSM		
	low 2	3	4	5	>5			
Soft storey	0	-15	-20	-25	-30	Absent =0 Present=1		
Vertical irregularities, setbacks, building	-10	-10	-10	-10	-10	Absent =0 Present=1		
Plan irregularities						None=0 Moderate=1 Extreme=2		
Heavy overhangs	-5	-10	-10	-15	-15	Absent =0 Present=1		
Apparent quality						Good=0 Moderate=1 Poor=2		
Short columns	-2	-5	-5	-5	-5	Absent =0 Present=1		
Foundings						Absent = 0 Unaligned floors= 2 Poor apparent quality of adjacent building = 2		
Soil condition						Medium = 0 Hard =1 Soft = -1		
Frame action	10	10	10	10	10	Absent = 0 Present =1 Not sure = 0		
Basement - Full or Partial	0	3	4	5	5	Absent = 0 Present =1		
						Σ (VSMXVS) =		
						-30		
Performance Score = Base Score - Σ (VSMXVS) =						90		

(b)

Figure 2. RVS form for RC frame buildings.

in building like frame action, pounding effect, structural irregularity, short columns, apparent quality, basement and heavy overhang present in the building. The base score, vulnerability score, and the vulnerability score modifiers have been calculated in order to get the performance score for the building. The formula for the evaluation of performance score for the present vulnerability assessment is based on the methodology proposed by Srikanth et al. (2010).

$$PS = (BS) + \sum [(VSM) \times (VS)] \dots (1)$$

Where Vulnerability Score Modifier (VSM) is multiplied to Vulnerability Score (VS) to obtain the actual modifier, which is then added to the Base Score (BS) in order to obtain the Performance Score (PS) of the building.

The data analysis for obtained performance scores of the 100 buildings in the region from RVS is done using a Gaussian (Normal) distribution method (Srikanth et al., 2010). This method is used for the statistical analysis of data sets. A normal distribution in a variate X with mean

μ and variance σ^2 is a statistic distribution with probability density function is given as:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)}{2\sigma^2}} \dots (2)$$

Generally, a cumulative probability refers to the probability that the value of a random variable falls within a specified range. Frequently, cumulative probabilities refer to the probability that a random variable is less than or equal to a specified value. The cumulative Distribution function, which gives the probability that a variate will assume a value $\leq x$, is then

$$f(x) = \int_{-\infty}^x P(x)dx = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^x e^{-\frac{(x-\mu)}{2\sigma^2}} dx \dots (3)$$

From this statistical analysis, the obtained performance scores of the buildings are distributed approximately normal. It helps to represent the probability that the obtained performance score is less than or equal to the



Figure 3. Distribution of various vulnerability parameters present in surveyed buildings.

specified value under the curve and to decide the cut-off range for the low, medium and high scores. Based on the obtained scores and its distribution, buildings were selected for further detailed evaluation.

RESULT AND DISCUSSION

The Performance score of the building depends on the base score and the vulnerability score. The Base score in the RVS form for a building depends on the seismic zone where it lies in, and the number of storeys. For 100 surveyed buildings, the number of storeys ranges from 2 to 6, which consists of 67 buildings having 5 storeys. 89 buildings out of 100 were the residential type. Figure 3 shows the distribution of the vulnerability parameters observed in buildings during the survey.

From RVS, it was observed that soft storey was present in 88 buildings, which are a significant number considering the fact that Murty et al., (2002) have reported the presence of this factor was also found in almost all of collapsed RC frame buildings of Ahmedabad during 2001 Bhuj earthquake. Figure 4 shows the presence of open ground storey which was observed in one of the flat/apartment type residential building to facilitate the vehicle parking. A surveyed building is shown in Figure 5 of G+4 storey has half of the ground storey left open which is used for the vehicle parking and another half of the ground storey used for the residence. Thus making the building partially open/soft storey. As also seen in Figure 5 the floor level of the left and the right portion of the building are not in the

same level, therefore, several irregularities can be observed both along the height as well as in the plan.

It is also reported (Murty et al., 2002) that the buildings with the poor quality of construction, horizontal irregularities (e.g., those with re-entrant corners such as L-shape plans) and those with vertical irregularities (e.g., vertical setbacks in structures), were common in the affected area. 48 surveyed buildings had vertical irregularities in the form of vertical setbacks. Figure 6(a) shows the presence of setback observed in the building at the time of the survey (approximate measurements taken using the google earth). Plan irregularities observed in the surveyed buildings in the form of the re-entrant corners. The pounding effect found to be existing in the 29-screened buildings. Figure 6(b) shows the location of pounding seen in a building, where the roof of the shorter building may pound at the mid-height of the columns in the taller building, which might be dangerous and can lead to storey collapse. Overhang found to exist in 51 buildings. Figure 6(c) shows the presence of overhang. Its presence will not lead to the collapse of the buildings but it might contribute to the building damage. Buildings also observed with the issue of poor quality of construction and maintenance, which may require moderate repairs. Figure 6(d) shows the building with poor construction quality. Presence of these vulnerability parameters can affect the performance of the buildings in an event of an earthquake if not properly designed for. Some surveyed buildings had suffered heavy damages in the 2001 earthquake. The carried out retrofitting works such as jacketing of column



Figure 4. Soft storey



Figure 5. Partial soft storey

and beam, wall thickening and adding of infill walls (RC/Brick filling) were observed in the survey. Figure 6(e) shows the retrofitting work column jacketing observed in a screened building.

Based on the performance scores and Gaussian Normal distribution, a conclusion can be drawn that higher the performance score lesser the vulnerability of the building to earthquake when compared to buildings having the low-performance score. Figure 7 shows the Gaussian distribution of the obtained scores for the surveyed buildings. The performance scores for the surveyed RC frame buildings in the study area are predominantly ranging from 20 to 125. The buildings in the middle range (43-

84) of performance score are large in number. However, there are some low-performance score buildings, which are potentially vulnerable to future earthquakes. The total number of buildings surveyed are 100 with mean and the standard deviation scores as 63.41 and 61.5 respectively. Hence, these scores are helpful in selecting buildings with a higher vulnerability for detailed evaluation. Building Vulnerability map is shown in Figure 8, it represents the building state based on the obtained RVS scores and applied statistical method. Here the building damage states like no damage, slight damage, moderate damage, severe damage, and collapse state are classified based on the $\mu-3\sigma$, $\mu-2\sigma$, $\mu-\sigma$, μ , $\mu+\sigma$, $\mu+2\sigma$, and $\mu+3\sigma$.



Figure 6. ((a) Vertical setback, (b) Possible location of occurrence of Pounding, (c) Overhang in form of jutting out balconies, (d) Poor quality of construction (e) Retrofitting through Column jacketing and steel I beam).

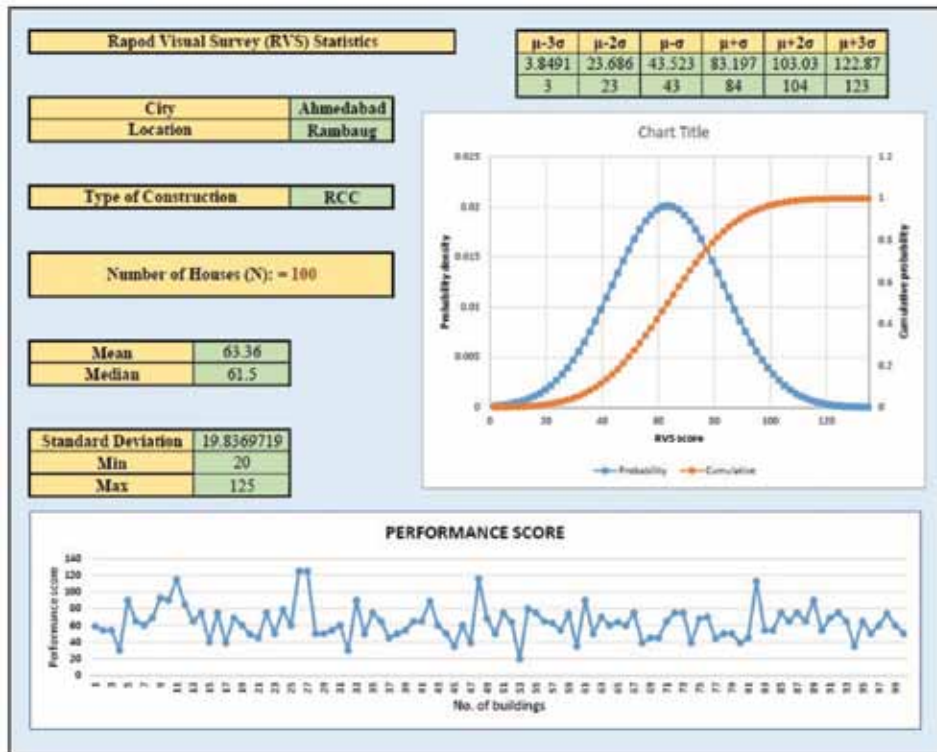


Figure 7. Gaussian distribution for surveyed buildings.

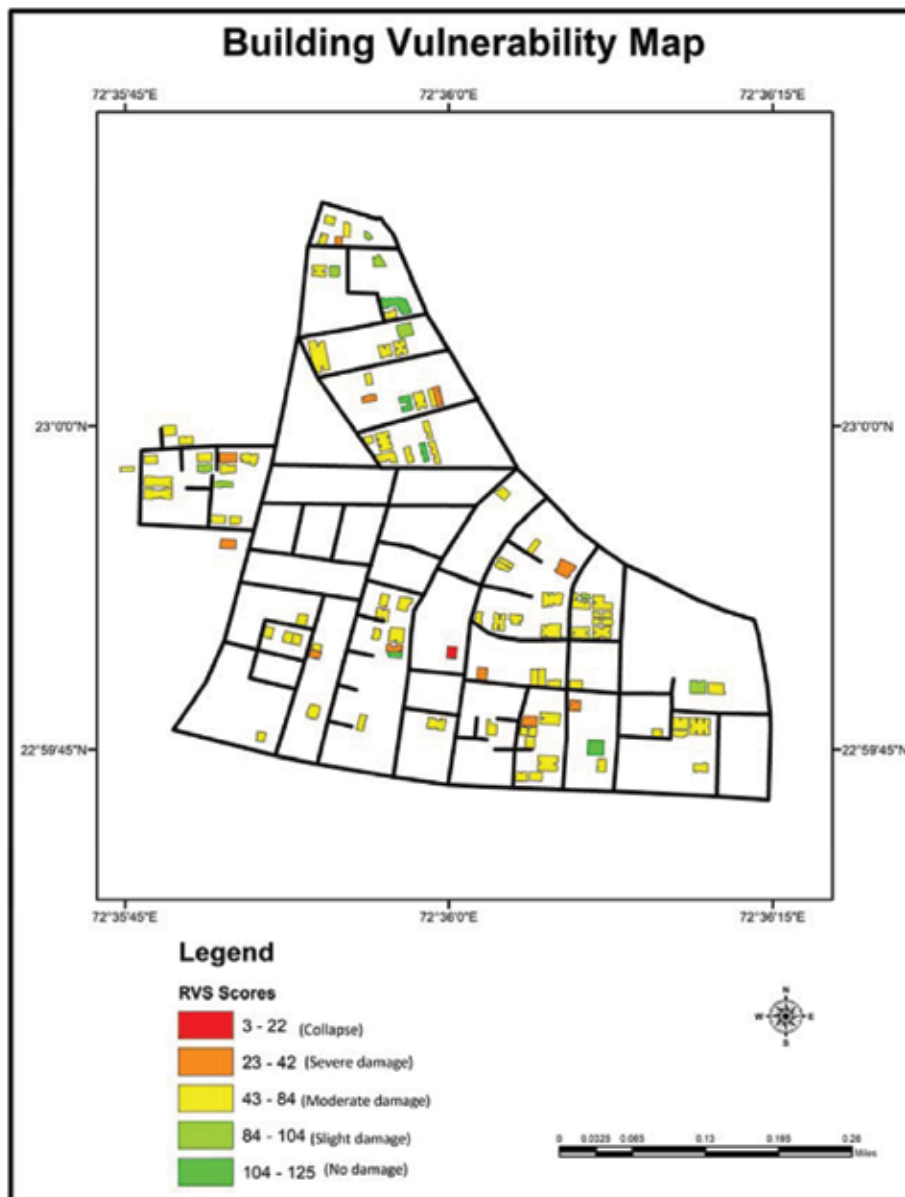


Figure 8. Building Vulnerability map

CONCLUSION

This study focuses on using RVS process in the Rambaug area of Ahmedabad where significant damage occurred during the 2001 Bhuj Earthquake. Total 100 RC frame type buildings were surveyed. The parameters considered for calculating RVS score are soft storey, vertical irregularity, plan irregularity, pounding, overhang, apparent quality, soil condition and short column. The collected data is analyzed, and each building is given a performance score based on its structural conditions. The area has soft soil conditions, which can have catastrophic effects on vulnerable buildings in this area. The past earthquakes

have revealed that the presence of the soft storey, heavy overhang, vertical irregularity, re-entrant corner and pounding effect in the buildings led to collapse/substantial damage. The result indicated that soft storey (88%), heavy overhang (51%), vertical irregularity (48%) and pounding effect (29%) were mostly observed which is alarming. The 38 surveyed buildings were observed with the moderate apparent quality in terms of maintenance as some of the buildings are approximately more than 16-18 years old. The presence of considered vulnerability parameters warrants a detailed evaluation of the selected building to quantify the vulnerability level for the study area. It is observed that the RVS scores range from 20 to 125. For the estimation

of building state/condition, a statistical method using the RVS score is used. Most buildings lie in the middle score range (43-84); however, there are also low RVS score buildings ranging from 3 to 23, which are vulnerable to future earthquake. The buildings with score less than or equal to 63 need to be analyzed in detail.

This type of work will help in distinguishing seismically vulnerable buildings for developing disaster mitigation programs. It can also help in predicting or estimating the damage that can happen due to an earthquake. Lives can be saved if we can predict the damage better by taking precautionary measures well in advance.

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Compliance with Ethical Standards

The authors declare that they have no conflict of interest and adhere to copyright norms.

REFERENCES

- Arya, A.S., 2000. Rapid visual screening of RCC Buildings. Disaster Risk Management–Document Series.
- Bhandari, N. and Sharma, B.K., 2001. Damage pattern due to January, 2001 Bhuj earthquake, India: Importance of site amplification and interference of shear waves, in: 2001 International Conference on Seismic Hazard with particular reference to Bhuj Earthquake, 26, 19-21.
- Chanu, N.M. and Nanda, R.P., 2018. A Proposed Rapid Visual Screening Procedure for Developing Countries. *Int. J. Geotech. Earthq. Eng.*, 9, 38–45. <https://doi.org/10.4018/IJGEE.2018070103>
- Dutta, S.C., Nayak, S., Acharjee, G., Panda, S.K. and Das, P.K., 2016. Gorkha (Nepal) earthquake of April 25, 2015: Actual damage, retrofitting measures and prediction by RVS for a few typical structures. *Soil Dyn. Earthq. Eng.*, 89, 171–184. <https://doi.org/10.1016/j.soildyn.2016.08.010>
- FEMA, 2002. Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook, Edition 2. Federal Emergency Management Agency Report, FEMA. P.154.
- FEMA, 2015. Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook, Third Edition. Federal Emergency Management Agency Report, FEMA. P.154.
- Ghosh, S.K., 2001. Observations from the Bhuj earthquake of January 26, *Pci Journal* 46(2), 34-42.
- IS 1893 Part I, 2016. Indian Standard Criteria for Earthquake Resistant Design of Structures (6th Rev.), Bureau of Indian Standards, New Delhi, India.
- Jain, S.K., Murty, C., Jaiswal, A., Shah, D., Mehta, V.V., Shah, R. and Desai, N.S., 2002. Postearthquake handling of buildings. *Earthq. Spectra* 18, 297–317. <https://doi.org/10.1193/1.2803917>.
- JBDPA, 2001. Seismic evaluation and retrofit. The Japan Building Disaster Prevention Association, Tokyo.
- Jain, S.K., Mitra, K., Kumar, M. and Shah, M., 2010. A proposed rapid visual screening procedure for seismic evaluation of RC-frame buildings in India. *Earthq. Spectra*, 26, 709-729. <https://doi.org/10.1193/1.3456711>
- Kumar, S.A., Rajaram, C., Mishra, S., Kumar, R.P. and Karnath, A., 2017. Rapid visual screening of different housing typologies in Himachal Pradesh, India. *Nat. Hazards*, 85, 1851–1875. <https://doi.org/10.1007/s11069-016-2668-3>
- Mathur, A.K., Saxena, A.K., Surendra Prasad, Fulzele, D.N., Singh V.N. and Regar, R.L., 2005. Seismic hazard and risk microzonation of Ahmedabad City, Gujarat. Report No. NSEL-008 Geological Survey of India (GSI), 75.
- Mishra, P.K., 2012. The Kutch earthquake, 2001: recollections, lessons, and insights, National Institute of Disaster Management, New Delhi.
- Murty, C., Goel, R.K., Goyal, A., Jain, S.K., Sinha, R., Rai, D.C., Arlekar, J.N. and Metzger, R., 2002. Reinforced concrete structures. *Earthq. Spectra*, 18, 149–185. <https://doi.org/10.1193/1.2803911>
- Nanda, R. and Majhi, D., 2013. Review on Rapid Seismic Vulnerability Assessment for Bulk of Buildings. *J. Inst. Eng. India Ser. A*, 94, 187–197. <https://doi.org/10.1007/s40030-013-0048-5>
- NRCC, 1993. Manual for screening of buildings for seismic investigation. Institute for Research in Construction, National Research Council Canada. Ottawa, Canada.
- NZSEE, 2006. Assessment and improvement of the structural performance of buildings in earthquakes, New Zealand Society for Earthquake Engineering (NZSEE), Wellington, New Zealand.
- Srikanth, T., Kumar, R.P., Singh, A.P., Rastogi, B.K. and Kumar, S., 2010. Earthquake vulnerability assessment of existing buildings in Gandhidham and Adipur Cities, Kachchh, Gujarat (India). *Eur. J. Sci. Res.*, 41, 336–353.
- Sucuoglu, H. and Yazgan, U., 2003. Simple survey procedures for seismic risk assessment in urban building stocks, in: Seismic assessment and rehabilitation of existing buildings. Springer, 97–118. https://doi.org/10.1007/978-94-010-0021-5_7
- Sucuoglu, H., Yazgan, U. and Yakut, A., 2007. A screening procedure for seismic risk assessment in urban building stocks. *Earthq. Spectra*, 23, 441–458. <https://doi.org/10.1193/1.2720931>

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