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Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Case Study of Chiplun City

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Abstract:-*The objective of this study is to assess the seismic vulnerability of R.C.C. and load bearing structure of the Chiplun City area by R.V.S (Rapid Visual Screening) method for Indian condition. The RVS method is a preliminary survey conducted to check the seismic vulnerability of existing structures in a systematic way. The method consists of the steps as, visual inspection followed by detailed investigation and finding a score which decides the need of detail seismic structural analysis. An attempt has been made to do rapid visual screening of RCC building and Load bearing building which available in Chiplun. RVS score has calculated for 40 buildings and plotted normal distribution Graph for each building to understand the distribution of RVS score of buildings in Chiplun. From the study, Results of the performance scores more than 2 around 57% (23 out of 40) of buildings are reinforced concrete as well as Load bearing structure also, Results of the performance scores more less than 2 around 43% (17 out of 40) of buildings are reinforced concrete as well as Load bearing structure. However, there are some low RVS score buildings which are potentially vulnerable to future earthquakes. Also it is suggested that preliminary analysis needs to be performed detailed analysis for 17 buildings for calibrating RVS scores.*

Key Words*: - Survey, Skill, Rapid visual screening, RVS forms for load bearing and RCC structure*

1. INTRODUCTION

The all humans are totally depends on the activity of earth. Some of activity are helpful some of the very danger to human life. For example three season summer, winter and rainy season are essential to human. In other hand volcano, tsunami, cyclone, greenhouse effect and earthquake are such most danger activity on our planet. Whereas the volcano, tsunami, cyclone are predicted before activity, so we can reduce the losses. But earthquake is most complicated and unpredictable activity on the earth.

We know that no any structure in the earth is totally earthquake resistance. But we can minimize the losses for earthquake by taking some precautions. India faces serious earthquake problems by a rapid growth of urban population. Nearly 60% of landmass in India is under moderate to severe earthquake prone area. During 2001 Bhuj preliminary assessment, and (c) detailed evaluation. Rapid visual screening (RVS) not only this, once the earthquake has occurred and disaster has taken place; how to use the debris to construct economical houses using this waste material without affecting their structural stability. Rapid visual screening of buildings for potential seismic hazards, as described here in, originated in 1988 with the publication of the FEMA 154 report.This FEMA 154 hand book is used all over word as a reference, But some of the parameters are not visualize for Indian condition, Making a new form of RVS.

II STUDY AREA

The town lies on the banks of the River Vashishti which flows up to Gowalkot, a village 2.5 km from Chiplun to the east of the city lay the Western Ghats and to the west lays Guhagar. The region has a tropical climate.

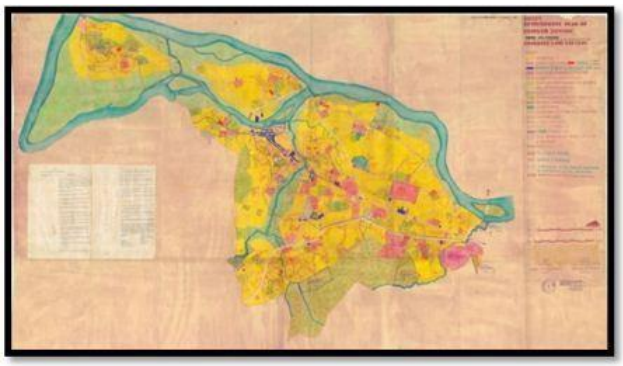


Fig 1 Map of Chiplun City

Hard Strata found up to 10 TO 15 Feet down and the water table is up to 35 TO 40 Feet below the ground level. (According to municipal data)

For that survey we select Chiplun city because of this city is very close to the Koyana Hydroelectric Project and this location is also high seismic zone which affect the Chiplun city after some year. Already Chiplun is in IV zone of seismicity so before earthquake occurs we have to ready for minimize the damages for structure and human life as well as economy also.

Chiplun is very old city so that there having more old structure in which include old wooden structures, steel with wooden structure, load bearing laterite structure and R.C.C. frame structures etc. Market area in the city is more crowded. This area having more than 500 shops (large and small), also in this market include Hospitals, Schools and

Colleges, Banks, Commercial Malls and parks. In this market more than 20000 peoples are working and running daily. This Chiplun city is also historical and tourist place so that in week end this population is increases. That's the reason to make a rapid visual screening of this city is required.

III METHEDOLOGY

The evaluation is based on a few parameters of buildings. The parameters of the buildings are building height, frame action, pounding effect, structural irregularity, short columns, heavy overhang, soil conditions, falling hazard, apparent building quality, diaphragm action etc. On the basis of above mentioned parameters, performance score of the buildings has been calculated.
The data collection form is completed for each building screened through execution of the following steps :

1. Verifying and updating the building identification information.

2. Walking around the building to identify its size and shape, and sketching a plan and elevation view on the data collection form.

3. Determining and documenting occupancy.

4. Determining soil type, if not identified during the pre-planning process.

5. Identifying potential non-structural falling hazards, if any, and indicating their existence on the data collection form.

6. Identifying the seismic lateral-load resisting system (entering the building, if possible, to facilitate this process) and circling the related basic structural hazard score on the data collection form.

7. Identifying and circling the appropriate seismic performance attribute score modifiers (e.g., number of stories, design date, and soil type) on the data collection form.

8. Determining the final score, S and deciding if a detailed evaluation is required.

9. Photographing the building and attaching the photo to the form (if an instant camera issued), or indicating a photo reference number on the form.

For present study more than 46 buildings form market area at Chiplun which includes load bearing structure, R.C.C. structure, steel structure and wooden structure are visually observed.

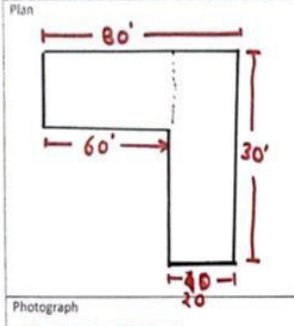
According to the study and preparing the RVS form filled with proper notification. After filling the form calculate the final score. This final score finalized that the building required detailed investigation or not required detailed investigation.

The example of the RVS form is developed for the Indian condition is show below.

Example 1

RAPID VISUAL SCREENING FORM FOR RCC BUILDING

Plan



Photograph

Building Name: Municipal Corporation (Old) Chiplun
Use: Public
Address: Main Bazar peth Chiplun. Pin. 415605
No. of stories: G+2 Year Of Const.: 2005
Storey Ht: 1st 12' 2nd 12' 3rd 12' 4th - etc
Total Covered Area: 1200 sqfeet.
Soil Type: Hard rock
Foundation Type: Open.
Depth of Ground Water Table: 15' to 20' below.
Thickness of infill wall :- Ext 09" Int 09"
Structural Drawing:- Yes / ~~No~~
Stair Case :- ~~Separated~~ / ~~Connected~~ /Enclosed
Type of Building: R.C.C.
Roof Type: Slab.
Wall Type: Mud brick.
Seismic band: Yes.
Structural components: Slab, Beam, Lintel, Plinth, Column, footing

Soil Type						Occupancy				
A	B	C	D	E	F	Assembly	Govt	Office	Number of persons	
Hard rock	Avg. rock	Dense soil	Stiff soil	Soft soil	Poor soil	Commercial	Historic	Residential	0-10	11-100
✓						Emer. Services	School	Industry	101-1000	1000+

FALLING HAZARDS IDENTIFIER 'F'

Marquees Hoardings Roof sign	✗	Structural Glazing	✗
AC unit / Grill work	✓	Location of Shear wall	✗
Elaborate parapet	✓	High of water table	✓
Heavy elevation feature	✓	Land Side prone site	✗
Heavy Canopies	✗	Severe Vertical Irregularity	✓
Substantial Balconies	✗	Severe Plan Irregularity	✓
Heavy Cladding	✗	Zone of Seismicity	IV

Base Scores (BS) and Vulnerability Scores (VS) for load bearing Buildings in India

	No of Stories	1 or 2	3	4	5	
Base Score	Seismic zone V	100	85	70	50	110
	Seismic zone IV	130	110	90	80	
	Seismic zone II & III	150	125	110	70	

(Source: Sudhir K. Jain and Keya Mitra 2008)

No of Stories	1 or 2	3	4	5	Vulnerability Scores Modifiers (VSM) for load bearing Buildings in India	(VS) x (VSM)
Vulnerability Scores (VS)					(VSM)	
Soil conditions	10	10	10	10	Medium=0, Hard=+1, Soft = -1	10
Apparent quality	0	-15	-20	-30	Good=0, Moderate=+1, Poor=+2	-30
Structural irregularities	-10	-10	-10	-10	Absent/Do not know=0; Exists=+1	0
Wall openings	-5	-5	-5	-5	Small=0, Moderate=+1, Large=+2	-5
Opening Orientation	-2	-5	-5	-5	Regular=0, Less regular=+1, Irregular=+2	0
Pounding Effect	0	-2	-3	-3	Does not exist=0, Non-aligned Floors=+1, Poor apparent quality of adjacent buildings = +2	0
Horizontal Bands	20	20	20	20	Present=+1, Absent=-1, Do not know=0	20
Arches	-10	-10	-10	-10	Present=+1, Absent/ Do not know=0	0
Diaphragm Action	10	10	10	10	Present/Do not know=0, Absent=-1,	0
Random Rubble Stone Masonry	-15	-15	-15	-15	Present=+1, Absent = 0	-15
Year of construction	-5	-10	-10	-15	Does not exist=0; >50 year Exists = +1 <50 year	-10

(Source: Sudhir K. Jain and Keya Mitra 2008)

COMMENT	Performance score $\sum BS + \sum i(VS) \times (VSM)i$	
Performance score 1.6 < 2 Detail evaluation required.		80

Fig 3 Structural damage and heavy overhang of Municipal building

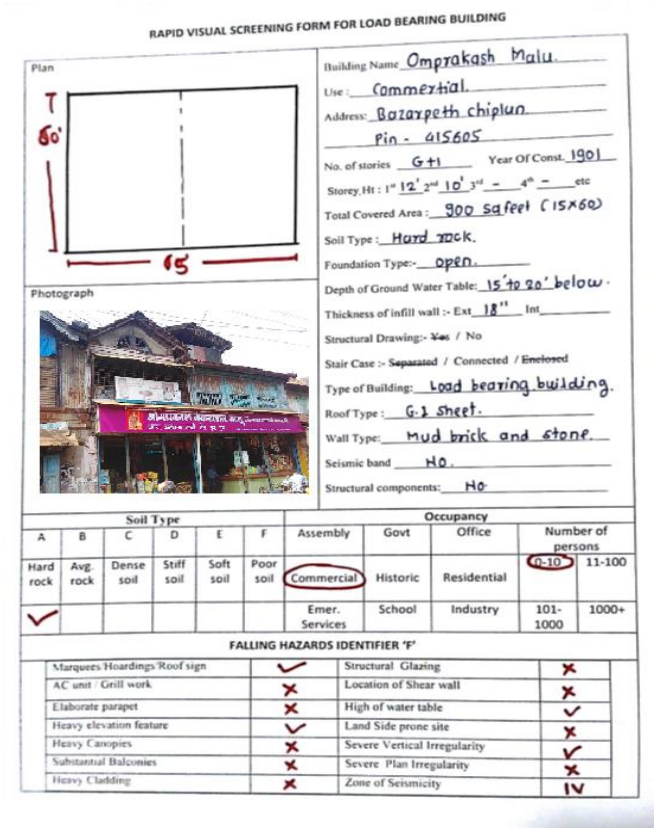
Fig 4 Rebound hammer test on Municipal building

COMMENT:-

The said structure is RCC structure. There are two buildings attached together one is old load bearing structure and another is RCC structure which is connected to the old building. The old structure is constructed in year 1942, whereas RCC structure constructed in 2002. The condition of the old structure is better than new structure which observes in figure 3. In new building observe plan and vertical irregularities which make structure instable for earthquake. The condition of the roofing is quite bad. Many of the sheets are breaks. In the building observe deflection in beam, crakes in wall as well as in plaster. Condition of Door and window are not good. The rebound hammer strengths of some beams are considerably low and may be liable toward the failure. The slab is also undergoing large amount of deflections at various location in overall structure. The cracks are also developed in the various columns of the structure. The bulking of columns are also observed during the survey. As per the rebound hammer results for various column sections, it is also observed that the strength of some columns are reducing considerably. The said structure does not seen to be suitable for any use. The performance score is less than 2, so building required detailed investigations.

Example 2

Fig 5 Internal structural condition of Om Prakash Malu Building



RAPID VISUAL SCREENING FORM FOR LOAD BEARING BUILDING

Plan

T
60'
15

Building Name Omprakash Malu.
Use : Commertial.
Address: Bazarpeth chiplun.
Pin - 415605
No. of stories G+1 Year Of Const. 1901
Storey.Ht : 1st 12' 2nd 10' 3rd – 4th – etc
Total Covered Area : 900 sqfeet (15×60)
Soil Type : Hard rock.
Foundation Type:- open.
Depth of Ground Water Table: 15' to 20' below.
Thickness of infill wall :- Ext 18" Int
Structural Drawing:- ~~Yes~~ / No
Stair Case :- ~~Separated~~ / Connected / ~~Enclosed~~
Type of Building: Load bearing building.
Roof Type : G.I sheet.
Wall Type: Mud brick and stone.
Seismic band No.
Structural components: No

Photograph

Soil Type						Occupancy				
A	B	C	D	E	F	Assembly	Govt	Office	Number of persons	
Hard rock	Avg. rock	Dense soil	Stiff soil	Soft soil	Poor soil	Commercial	Historic	Residential	0-10	11-100
✓						Emer. Services	School	Industry	101-1000	1000+

FALLING HAZARDS IDENTIFIER 'F'

Marquees Hoardings/Roof sign	✓	Structural Glazing	✗
AC unit / Grill work	✗	Location of Shear wall	✗
Elaborate parapet	✗	High of water table	✓
Heavy elevation feature	✓	Land Side prone site	✗
Heavy Canopies	✗	Severe Vertical Irregularity	✓
Substantial Balconies	✗	Severe Plan Irregularity	✗
Heavy Cladding	✗	Zone of Seismicity	IV

Base Scores (BS) and Vulnerability Scores (VS) for load bearing Buildings in India

Base Score	No of Stories	1 or 2	3	4	5		130
	Seismic zone V	100	85	70	50		
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(Source: Sudhir K. Jain and Keya Mitra 2008)

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Diaphragm Action	10	10	10	10	Present/Do not know=0, Absent=-1,	-10
Random Rubble Stone Masonry	-15	-15	-15	-15	Present=+1, Absent = 0	-15
Year of construction	-5	-10	-10	-15	Does not exist=0; >50 year Exists = +1 <50 year	-5

(Source: Sudhir K. Jain and Keya Mitra 2008)

COMMENT	Performance score $\sum BS + \sum\{(VS) \times (VSM)\}$	73
Performance score - 1.46 < 2 Detail evaluation is required.		

COMMENT:-

This is the old load bearing of composite steel and wooden structure. The structure is constructed in year of 1901.This structure located at main market area. The constructed area of the building is more about 1500 to 1600 sqfeet. Today this structure is used for the shop only not for residence. The building having pounding effect as well as not in good condition. The structure having G + 1 structure. Ground floor is almost used in shop but first floor condition is bad and required maintains, which shown in the fig 5. The RVS score is less than two, so required detailed evaluation.

IV CONCLUSIONS

An attempt has been made to do rapid visual screening of RCC building and Load bearing building which available in Chiplun. RVS score has calculated for 40 buildings and plotted normal distribution Graph for each typology of building to understand the distribution of RVS score of buildings in Chiplun.

- From the study, Results of the performance scores more than 2 is around 57% (23 out of 40) of buildings are reinforced concrete as well as Load bearing structure also, Results of the performance scores more less than 2 is around 43% (17 out of 40) of buildings are reinforced concrete as well as Load bearing structure.

- There are some low RVS score buildings which are potentially vulnerable to future earthquakes. Also it is suggested that preliminary analysis needs to be performed detailed analysis for 17 buildings for calibrating RVS scores.

- In the study found that some of the building performance score is more than 2, but in observation it is found that the building having structural damages, so that this building requires detailed evaluation of that building.

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BIOGRAPHIES

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