CONDITIONAL ASSESSMENT OF EXISTING SCHOOL STRUCTURE USING N.D.T. TECHNIQUE ALONG WITH STAAD.PRO

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Abstract

In old protection, there is a vital necessity to recognize the impending seismic risk in prevailing historic buildings for hazard moderation, disaster alertness and preceding knowledge of probable hazards. Seismic risk estimation remains centred on safety assessment, which necessitates qualitative and computable data.

Obtaining the computable data is a thorough method, which demands specialists and takes extra time and money. The fact that there are numerous old buildings and a limited professional in this arena, it is very significant to create condition survey based on visual inspection as the first step of safety assessment technique.

This work aims to existing condition survey standards in general and laid emphasis on visual examination of the RC structure. The data given in this research is a visual examination method for judging the risk level of masonry monumental historic structures and then numerically analyzing the building by using equivalent static method and finally comparing the base shear, ensuring the safety of the structure from the damage due to seismic effects. The dissertation deals with Hamidia Girls School, Bhopal (MP), as a case study using analysis tool staad.pro. in this study, the weakest section of the structure is determined.

Here it is concluded that the weakest section can be repaired using retrofitting technique by assigning a sectional member of size 300 x 300 mm which is checked in staad.pro and observed as safe.

Keywords: Seismic assessment, RC structure, Staad.pro, N.D.T, rebound hammer, forces, stress.

Introduction:

India is a developing nation but due to the tremendous increase in population, development concentration around urban areas and limited land chunk the population density in cities is increasing

day by day. The increased population density resulted in the growing demand for high rise buildings. In high rise building due to accumulation of load of all stories, vertical gravity load of columns dominates the design of building structure. The composite structure is being used as an alternative to steel structures due to its benefits over RCC structure and high cost of steel structure.

An Earthquake is a natural disaster that unlike the other disasters like floods etc leaves no time for evacuation of people to safer places thus causing a huge loss of lives as well as property. Hence designing our buildings to resist these seismic loads is the only feasible alternative. Each damage case has provided important information for improving the design and construction practices thus trying to protect the occupants of the buildings. This chapter includes the code based procedure for seismic analysis, structural modelling concept and objective of the present study.

Seismic analysis of most of the structures is still carried out on the basis of lateral force assumed to be equivalent to the actual loading. The base shear which is the aggregate even power on the structure is computed on the premise of structure mass and key time of Vibration and comparing mode shape. The base shear is appropriated along with the stature of the structure as far as sidelong powers as indicated by code equation. This strategy is normally traditionalist for low to medium stature structures with a general configuration.

In this study, we are determining the strength of an existing school (hamidia girls school) which was built 30 years before as per working stress method. In this study first we are determining its strength using NDT (rebound hammer) over distributing and main members. Also performing seismic evaluation using analysis tool to check its reset stability and stiffness.

Seismic evolution of RC structures

The term earthquake can be used to describe any kind of seismic event which may be either natural or initiated by humans, which generates seismic waves. Earthquakes are caused commonly by rupture of geological faults; but they can also be triggered by other events like volcanic activity, mine blasts, landslides and nuclear tests. An abrupt release of energy in the Earth's crust which creates seismic waves results in what is called an earthquake, which is also known as a tremor, a quake or a temblor). The frequency, type and magnitude of earthquakes experienced over a period of time defines the seismicity (seismic activity) of that area. The observations from a seismometer are used to measure earthquake. Earthquakes greater than approximately 5 are mostly reported on the scale of moment magnitude. Those smaller than magnitude 5, which are more in number, as reported by the national seismological observatories are mostly measured on the local magnitude scale, which is also known as the Richter scale.

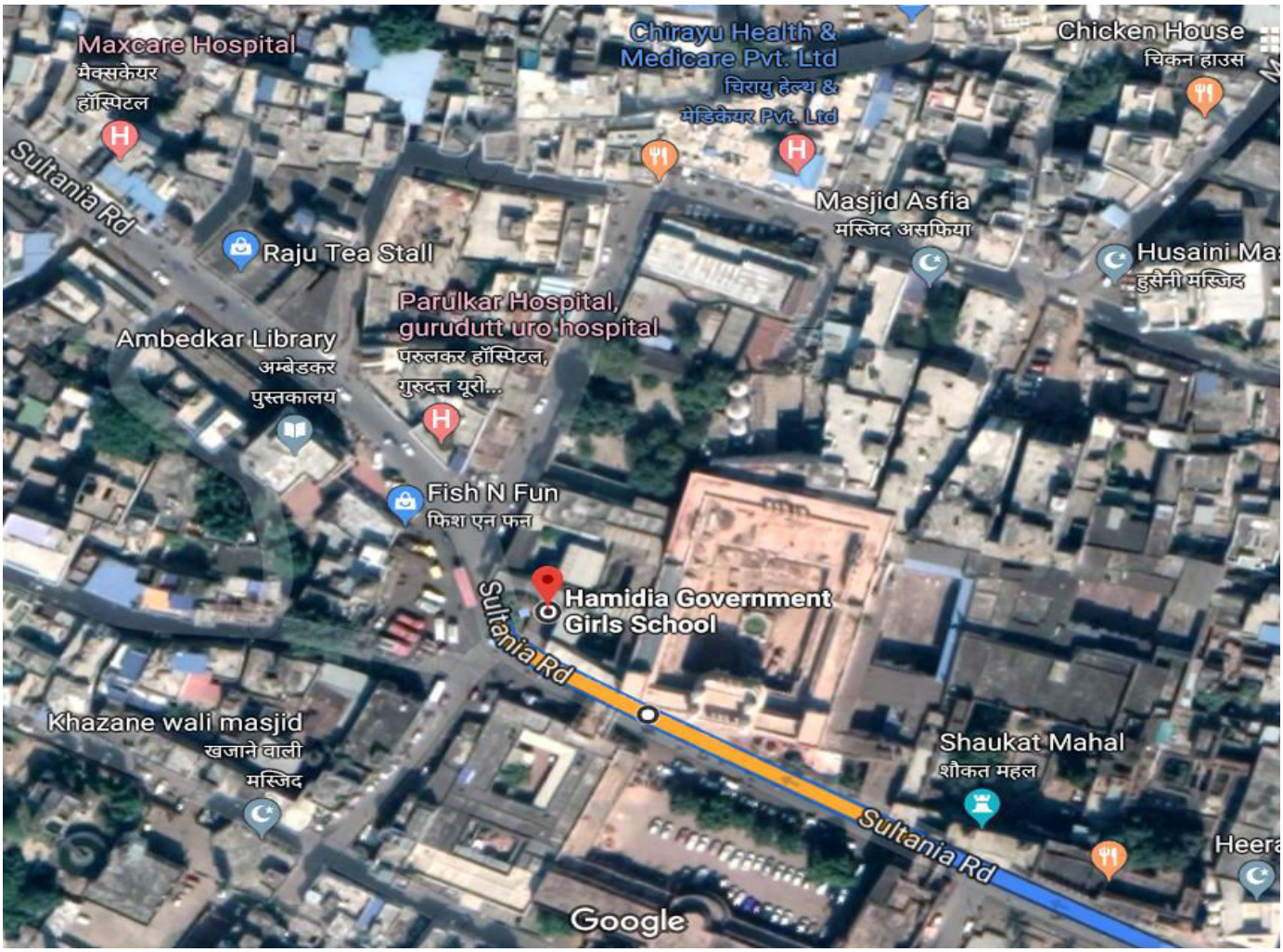

Fig 1: Hamidia Girls school Bhopal

About Hamidia Girls School

Hamidia girls school built in 1978, by the state government of M.P. with the motive of providing education to the girls of minor communities and below poverty line family.

The school's campus is located in the old city area near Chirayu hospital and Shaukat Mahal. It has a small playground located in front. The school offers classes inHindi medium of instruction. It has classes from Standard I to XII. The streams offered at a higher level include Science, Arts, Commerce and Vocational.

The school structure is G+1 unsymmetrical in shape with open span in between for prayer and gathering purpose.

Literature review:

Burak Yon & Onur Onat (2018) here the author analyzed existing reinforced concrete buildings before and after shear wall retrofitting. While investigating the seismic behaviour of existing reinforced concrete buildings before and after seismic retrofitting, the authors found that the capacity curve of the retrofitted building is larger than that of the existing building. This situation proved that the shear wall increases the capacity of the building. For the existing building, responses of the existing structure during the low amplitude ground motion was close to the capacity curve of the same model.

Sakalle et. al. (2018) Author studied the analysis of frames and manually checked the accuracy of the software and compared results. Concluded that by using STAAD.Pro that is very interactive software and user interface which gives the result according to seismic code (IS1893). Then according to the specified criteria assigned it analyses the structure and analysis the structure in different seismic Zone. In this paper, we have to calculate such parameter as storey drift, displacement, Lateral forces, bending moment, Shear force, & axial forces.

Premalatha & Mrinalini (2018)the author study described a retrofitting system of the existing four-storey reinforced concrete building located in PES University Bangalore, design for vertical loads of extra two-storey structure. The structural analysis performed on the inspected building presented its inability to withstand any additional loads. Therefore the redesign of such building through retrofitting of existing columns and footing was assessed through structural analysis carried out on analytical application Stadd. Pro. present footing and columns were not capable of taking the loss of G+5 building with the existing size

of footings and columns. The retrofitting design carried out for G+ 5 building presented that the retrofitted g +5 building was safe from all loads except seismic load which was not considered in the author study.

Objectives:

The primary objectives of our research work are to find the followings:

1. To evaluate the present condition of Hamidia girls school using rebound hammer.
2. To evaluate seismic assessment impact on school building for Zone III using analysis tool.
3. To determine the weakest portion of the structure and propose suitable retrofitting technique.

4. **Investigation steps of condition survey of Hamidia Girls School are given briefly:**
5. • Reviewing the schematic data and drawing of the structure (Nagar Nigam).
6. • Study the history of the structure,
7. • Attaining metric data of structural elements,
8. • Visual review of the structure by aiming at the existing decay and damage state of structural elements.
9. • Conditional Assessment of structural members using the rebound hammer.

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Damages observed in visual investigations			
Figure No.	Element	Damage	Location
1	Beam	Major Cracks are observed	
2	Columns	major Cracks are observed	
3	Columns	Major Cracks are observed	
4	Beam	Major Cracks are observed	

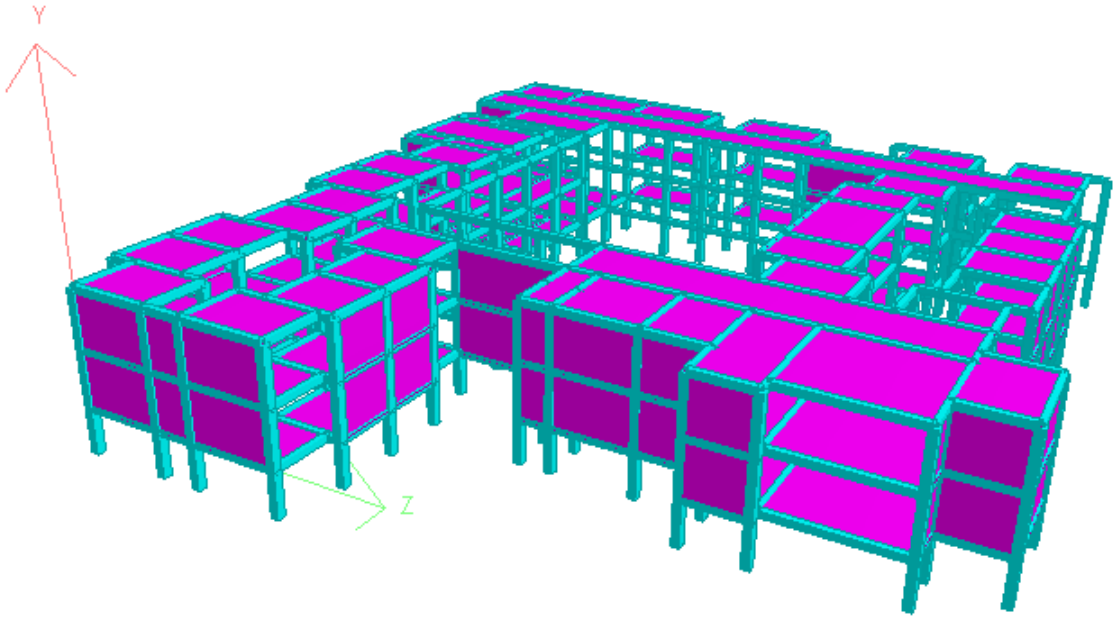

Fig 2: Modelling of the structure

Table 1: N.D.T Test result Column

Column No.	Rebound Number			Compressive Strength (M/mm^2)			Average Compressive Strength	Position
	Top	Mid	Bottom	Top	Mid	Bottom	(N/mm2)	
C1	**26**	**27**	**25**	16.2	16.5	16.1	**16.27**	Horizontal
C5	**28**	**25**	**25**	16.6	16.2	16.05	**16.28**	Horizontal
C7	**27**	**26**	**28**	16.45	16.3	16.8	**16.51**	Horizontal
C11	**25**	**27**	**26**	16.1	16.5	16.2	**16.26**	Horizontal
C13	**24**	**25**	**24**	15.5	16.1	15.5	**15.70**	Horizontal
C15	**24**	**23**	**23**	15.5	15	15	**15.16**	Horizontal

Table 2: N.D.T Test result Beam

Beam No.	Rebound Number			Compressive Strength (M/mm^2)			Average Compressive Strength	Position
	Top	Mid	Bottom	Top	Mid	Bottom	(N/mm2)	
B3	**30**	**30**	**31**	15.6	15.7	16.2	**15.83**	Upward
B20	**32**	**30**	**31**	16.5	15.5	15.7	**15.90**	Upward
B26	**31**	**30**	**30**	16.2	15.45	15.68	**15.77**	Upward
B31	**29**	**30**	**30**	15	15.6	15.7	**15.43**	Upward
B38	**30**	**29**	**28**	16.2	15.2	15.1	**15.50**	Upward
B42	**28**	**30**	**30**	15	16.2	16	**15.73**	Upward

Geometric properties

Table 3: Geometric properties of Structure

RC Structure	Dimensions (m)
Plan dimension	17.8 x 13.5
Length (m)	17.8 m
Width (m)	13.5 m

Height (m)	7 m
Parapet Height (m)	1.2 m
Open Area (m)	17.8 x 3
Existing column size	350 x 300 mm
Existing beam size	300 x 200 mm

Analysis Results:

Table 4: Support Reaction

Node	Force-X kN	Force-Y kN	Force-Z kN	Moment-X kNm	Moment-Y kNm	Moment-Z kNm
227	-1.095	1983.803	0	0	0	-0.523
228	4.997	1733.389	0	0	0	-3.858
226	3.791	1305.929	0	0	0	-5.456
221	12.374	1052.364	0	0	0	-9.415
215	1.05	782.256	0	0	0	-0.796
208	3.276	514.789	0	0	0	-4.305
220	-11.326	461.355	0	0	0	8.925
225	-0.844	460.969	0	0	0	-2.47
207	-0.611	393.41	0	0	0	-1.323
238	-1.815	346.078	0	0	0	1.727
214	-0.792	264.799	0	0	0	0.564
176	1.247	261.904	0	0	0	-2.689
241	-47.745	245.695	0	0	0	63.626
187	-61.933	230.949	0	0	0	83.548
179	-45.388	187.339	0	0	0	60.329
183	-53.85	180.932	0	0	0	71.388

Table 5: Plate Stresses

Plate	SQX N/mm2	SQY N/mm2	MX kNm/m	MY kNm/m	MXY kNm/m	SX N/mm2	SY N/mm2	SXY N/mm2
4446	0.012	0.102	0.469	2.758	3.121	-0.059	-0.35	-0.463
4379	0.018	0.027	0.433	2.546	0.864	-0.101	-0.594	-0.265
4958	0.014	0.023	-0.04	-0.237	0.552	-0.04	-0.235	-0.543
4471	0.001	-0.008	-0.039	-0.228	0.213	-0.005	-0.028	0.031
4446	-0.025	-0.003	-0.046	-0.268	0.181	0.001	0.004	0.003

4395	-0.005	0.006	-0.186	-1.094	0.136	-0.027	-0.161	0.128
4393	-0.008	0.001	-0.162	-0.951	0.124	0.028	0.165	-0.134
4445	0.001	0.004	0.098	0.577	0.122	-0.024	-0.142	-0.207
4887	-0.005	0.005	-0.322	-0.055	0.122	0.002	0	0
4950	-0.005	0.005	-0.306	-0.052	0.115	0.002	0	0.002
4879	0.001	0.008	-0.066	-0.387	0.106	0.005	0.031	-0.009
4896	-0.004	0.004	-0.051	-0.299	0.101	0	-0.001	-0.002
5010	-0.004	0.005	-0.235	-0.04	0.098	-0.008	-0.001	-0.021

Reinforcement jacketing of the structure

It is one of the techniques used to improve or restore the capacity of reinforced concrete column. The size of the jacket and the number and diameter of the steel bars used in the jacketing process is as per the structural analysis that was made to the column and beam. It is the most common and easy to apply technique of retrofitting, here the structural members whose strength is not within the safety criteria and require repairing are repaired using RC member jacketing technique.

Cost Analysis of Jacketing of Weak Members:

Table 6: Cost Analysis of jacketing Weakest section of the building

Material	S.O.R. Rate	Quantity	Total Rate
Steel Casing	68 / kg	4154.91	2,82,533.608/-
Concrete	5091 / cu. M.	30.08	1,53,137.28/-

Cost Analysis of Members assigned with jacketing to enhance structural stability and life, In this analysis we selected the weakest members and assigned jacketing which cost as shown in above table.

Conclusion:

In this study, we have performing seismic assessment of an old RCC structure school building located at the centre of city of lakes.

- Firstly the project was initiated by measuring the dimensions and area of structural members.
- Secondly, the performance of N.D.T was done over a clear surface of beam and column so as to determine its current strength.NDT methods are very effective in health monitoring of buildings, by following the procedures as mentioned in IS 13311.1 reliable results can be obtained and there by the present strength of the building can be evaluated. In this project NDT tests such as Rebound Hammer & UPVT were done on a school building which is more than 50 years old. The strength of beams, slabs & load bearing walls were tested using these NDT tests.
- Thirdly, modelling of the structure was done using Staad.pro from the data generated by N.D.T and seismic load Zone III as per IS 1893 2016.
- Forth, after the analysis, the force, moment, deflection, support reaction and stresses were determined. The results concluded that weak sections highlighted in the previous chapter need to be retrofitted as a structural body using beam addition method by adding beams between the main girders of the existing reinforced concrete deck to reduce the deck span and restore or improve the load carrying capacity of the reinforced concrete deck or using Support point addition method where supporting the intermediate sections of the beams and other existing concrete members with new members to reduce the span of the members in order to restore or improve the load carrying capacity as a structure.

In this study, it can be said that Hamidia school which was built as per W.S.M. method was observing failure at certain members and joints which can be said as a severe issue which is needed to be resolved early as possible.

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