

Capacity Estimation of RCC Frame Structured Building for Seismic Vulnerability with Reference to Structural Assessment using NDT – A Case Study

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ABSTRACT: As time passes, there is a degradation of concrete structures. This may be due to various diffusive environmental actions such as carbonation, alkali aggregate reactions, etc. The load carrying capacity and strength of concrete decreases due to degradation. On the other hand seismic codes are also frequently revised with the advancement in research and technology and knowledge gained after recent earthquakes. Hence, the old structures need to be evaluated from the point of its seismic vulnerability. In this paper, seismic vulnerability assessment of J P Tower, Wing C, Nagpur has been presented. The assessment has been carried out using E-Tabs software as per IS 1893-2016 using the strength of concrete obtained by Rebound Hammer test. After analysis, it was observed that the building was stable for earthquake loading.

KEYWORDS: Degradation, carbonation, alkali aggregate reaction, seismic vulnerability, retrofitting.

I. INTRODUCTION

In this era of modern development, the safety and serviceability of structures is an important parameter. Most of the existing structures that are designed as per old codes do not satisfy the requirements of modern code. Hence it is very important to see whether all the buildings satisfy current standards for following purposes:

- Pre earthquake vulnerability check.
- Post-earthquake vulnerability check.
- Additions and alterations in existing buildings.
- Safety and Stability check for buildings.

In India, the seismic risk has been increasing rapidly in the recent years and country has failed in ensuring earthquake-resistant constructions in high seismic regions. Major earthquake events in India are rare but casualties caused in these are very high and each earthquake is characterized by high exposure and their economic and social effects cannot be neglected.

In India, in last few years various old structures have been collapsed. This is because these structures have become too old and due to which the strength of the structure got reduced. This has also led to loss of lives in our country.

Hence, in order to prevent this, it is very essential to assess the structural parameters of existing old structures and reanalyse it and thus check for safety and stability of such structures. Hence prevent the structure from collapsing by using suitable retrofitting measures.

Many studies have been carried out to achieve this aim but still there is much scope in this field. The number of experimental studies have investigated the strength of the building by Rapid Visual screening method. In this paper we have assessed the strength by Non-destructive techniques and then reanalysed the building using E-TABS software.

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II. RELATED WORK

As per H. D. Shrestha, R. Yatabe, N. P. Bhandary and J. Subedi et.al.[1], Preliminary physical assessment and drawing verification of 58 school buildings was done. Schmitt hammer test was performed to obtain compressive strength. Core drilling, Profometer, SPT was done to obtain other properties of material. Then bending capacity and Shear capacity was calculated. Modelling of building was done in SAP 2000 and analysed. Experimental and software results were compared. Replacement cost and Retrofitting cost was also compared based on results and Retrofitting was suggested.

As per T. Srikanth, R. P. Kumar, A. P. Singh, B. K. Rastogi and Santosh Kumar et.al [5], 16000 buildings of Gandhidham and Adipur cities were selected and data was collected for Rapid Visual Screening of all buildings. RVS score for all buildings was calculated and detailed analysis of 300 buildings was suggested with RVS score less than 120.

As per chandrabhakuni [10], assessment was carried out on 160 schools of Gujarat. 90 % of schools were RCC and CM type. Based on visual assessment seismic behavior was estimated considering building type and performance modification factor. Expected seismic performance was found to be in vulnerability class C, D and E. School population was then correlated with expected seismic behaviour. School with higher population was considered more vulnerable. Degree of vulnerability was found very high for 19% buildings and high for 41% buildings.

III. GENERAL DATA OF BUILDING

The building is a residential building situated at Nagpur. The building is 28.16 m long and 12.98 m wide.

- The building can be categorized as RCC framed structure residential building.
- The building is constructed on fairly level ground with foundation strata having the SBC of 250 – 300 kN/Sq.m.
- The building is a Ground + 5 storied RCC framed structure with 230 mm thick External and 150mm / 115 mm thick brick masonry walls with RCC slab provided at top.

IV. NON-DESTRUCTIVE TEST ON BUILDING

The building had become too old and cracks were also noticed in many parts of the building. Hence, NDT was suggested to evaluate the strength of the building and also to evaluate seismic stability of building.

Following conclusions were drawn from the results of Non-destructive tests performed on building.

1. Cracks were noticed on some of the columns, especially those located on outer side.
2. Spalling of concrete was noticed in beams and at places, the reinforcement is exposed and is undergoing corrosion.
3. The UPV test indicated deficiency in homogeneity at some places.
4. The cover to the reinforcement appears to be adequate but depth of carbonation is high.
5. The chances of corrosion of rebars is over 50%.
6. The characteristic compressive strength of building is found to be 17.50 MPa.

TABLE 1. Existing schedule beam at floor level

BEAM NO.	WIDTH	DEPTH	BEAM NO.	WIDTH	DEPTH
B1	260	325	B38	260	325
B2	260	325	B39	260	325
B3	260	325	B40	260	325
B4	260	325	B41	260	325
B5	260	325	B42	260	325
B6	260	325	B43	115	325
B7	260	325	B44	260	325
B8	260	325	B45	260	325

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BEAM NO.	WIDTH	DEPTH	BEAM NO.	WIDTH	DEPTH
B9	260	325	B46	260	325
B10	260	325	B47	260	325
B11	260	325	B48	260	325
B12	260	325	B49	260	325
B13	260	325	B50	260	325
B14	260	325	B51	260	325
B15	260	325	B52	260	325
B16	260	325	B53	260	325
B17	260	325	B54	260	325
B18	260	325	B55	260	325
B19	260	325	B56	260	325
B20	260	325	B57	260	325
B21	260	325	B58	115	325
B22	260	325	B59	260	325
B23	260	325	B60	260	325
B24	260	325	B61	260	325
B25	260	325	B62	260	325
B26	260	325	B63	260	325
B27	260	325	B64	260	325
B28	260	325	B65	260	325
B29	260	325	B66	260	325
B30	260	325	B67	260	325
B31	260	325	B68	260	325
B32	260	325	B69	260	325
B33	260	325	B70	260	325
B34	260	325	B71	260	325
B35	260	325	B72	260	325
B36	260	325	B73	260	325
B37	260	325	B74	260	325

TABLE 2. Existing schedule of Columns

COLUMN NO.	WIDTH	DEPTH	COLUMN NO.	WIDTH	DEPTH
C1	260	490	C25	260	525
C2	260	490	C26	260	490
C3	260	490	C27	260	525
C4	260	430	C28	260	510
C5	260	430	C29	260	490
C6	260	430	C30	260	510
C7	260	430	C31	260	525
C8	260	490	C32	260	525
C9	260	525	C33	260	525
C10	260	490	C34	260	490
C11	260	490	C35	260	510
C12	260	510	C36	260	525
C13	260	525	C37	260	525
C14	260	510	C38	260	525

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COLUMN NO.	WIDTH	DEPTH	COLUMN NO.	WIDTH	DEPTH
C15	260	510	C39	260	510
C16	260	490	C40	260	490
C17	260	510	C41	260	490
C18	260	490	C42	260	425
C19	260	510	C43	260	425
C20	260	510	C44	260	450
C21	260	510	C45	260	450
C22	260	525	C46	260	475
C23	260	510	C47	260	510
C24	260	510	C48	260	510

TABLE 3. Existing schedule of Slab

SLAB NO.	THICKNESS
S1	125
S2	125
S3	125
S4	125
S5	125
S6	125
S7	125
S8	125
S9	125
S10	125
S11	125
S12	125
S13	125
S14	125
S15	125

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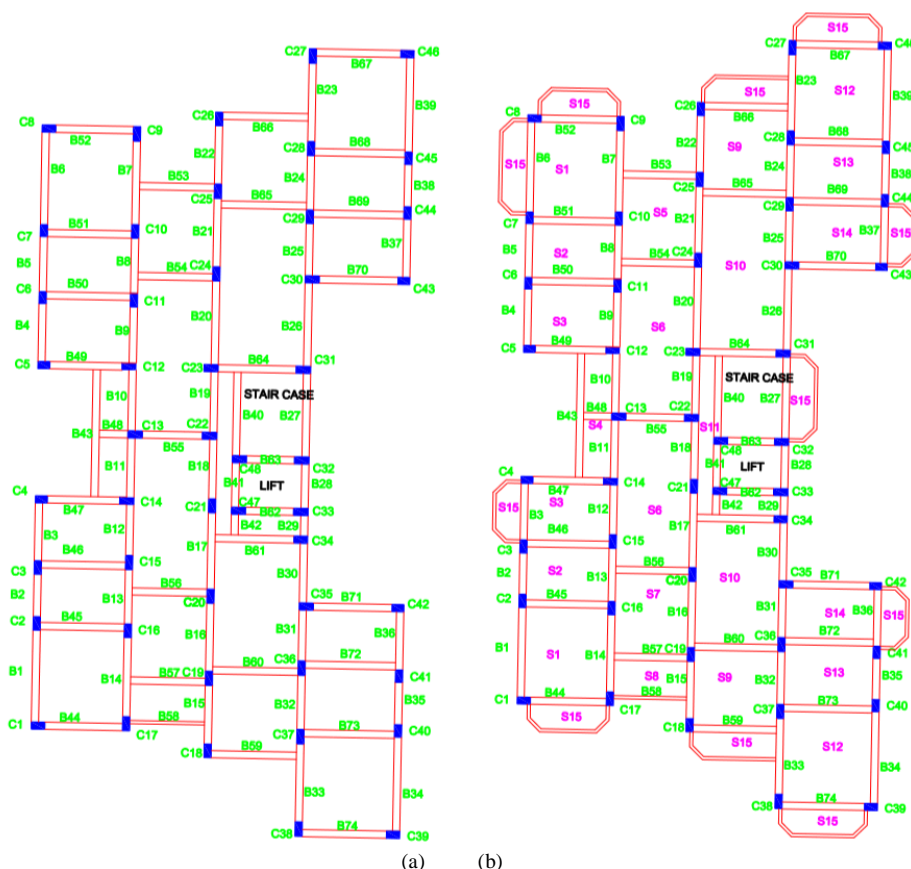


Fig. 1. Existing structural layout of building (a) At Plinth Level (b) At floor levels

V. OBSERVATIONS

After collecting all the information such as existing plans of building as shown in fig. 1 and schedules of building as given in tables 1-3, the building was analysed using ETABS software by using the above mentioned details of building for Earthquake loading. From the analysis it was found that the building was stable for earthquake loading.

Similarly depth of slab and footing were also compared in order to check for the safety of the same for the earthquake loading.

TABLE 4. Comparison for Slab depth

SLAB NO.	THICKNESS PROVIDED	THICKNESS REQUIRED	REMARKS
S1	125	88	PASS
S2	125	65	PASS
S3	125	71	PASS
S4	125	77	PASS
S5	125	81	PASS
S6	125	80	PASS

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SLAB NO.	THICKNESS PROVIDED	THICKNESS REQUIRED	REMARKS
S7	125	81	PASS
S8	125	54	PASS
S9	125	83	PASS
S10	125	89	PASS
S11	125	55	PASS
S12	125	93	PASS
S13	125	70	PASS
S14	125	64	PASS
S15	125	77	PASS

VI. CONCLUSION

From the above observations it is clear that all sections of the existing building are safe. Hence the building is stable for earthquake loading. However, from the results of NDT it is observed that various sections are deteriorated from their original sizes at some places. All such sections should be retrofitted to their original sizes by using suitable retrofitting technique.

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