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EXTENSION OF FLOORS IN RCC BUILDING

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Abstract

This research explains the basis of the structural design process, by way of familiarizing with the requirements of the project and understanding the architectural and services concepts. This research aims at formulating the main design parameters that we will adopt in developing the structural design and detailing of the structure which will be compatible with the architectural theme, satisfy the functional needs, adhering to other applicable building norms and Indian Standards provisions to achieve a safe & stable structure.

In this research the structural design to be adopted for the proposed structure covers the minimum design requirement to establish the unified design basis that will form the overall design philosophy.

The design aims to achieve the following: -

- Structural & functional integrity.
- Required Structural performance under the consideration of characteristic service design loads.
- Design for wind and earthquakes loads. As this is an old structure the same will be checked as per latest IS standards to establish the resistance value.
- Structural durability & maintainability. The current state of the structure is such that if repairs required will be carried out in order to enhance its life.

I] Introduction:

The building was constructed in 1986. The structure was planned as industrial building which comprised of 1 Basement, Ground floor level. Office floors start above Ground Floor Level and extend up to 3rd Floor Level. This building also has a Terrace Floor Level along with an Overhead Tank & Lift Machine Room. The Elevation treatment of the building as seen on the image aside is built in brickwork. There is a 6m driveway all around the building sides. The outside ground level is sloped such that one side there is a basement and on other the same basement is visible from the ground floor. There is a hill road outside this building due to which the ground is sloped.

II] Purpose of study:

- The possibility of adding the proposed floors and its impact on the existing building structure is the main purpose of this research. The structural health condition of the existing structure will also be studied such that improvising and strengthening procedures can be adopted as necessary, to augment the building structural health.
- Considering the building will host one new floor, it is necessary to carry out a comprehensive study of its load-bearing capacity in order to identify any elements that will have to be removed. This will include obsolete elements like storage rooms, old water tanks, any loft slab etc. This process allows us to create a balance between the removed weight and the added weight.
- Generally, the reverse load calculation is carried out with the help of existing structural drawings, where structural drawings are not available in such cases Non-destructive and Destructive tests are performed to find out the strength of concrete.
- This will give us the required information to calculate the load of the structure, determining the need (or not) to reinforce the existing structure and foundation.
- There are a lot of repair activities also as the existing structure is in a deteriorated condition at several locations. All loose material will be removed from the external plaster and the new concrete polymer mortar will be built up over the removed material at places if the build-up of concrete is thicker then Micro- concrete will be suggested.
- A new Under-ground water tank is proposed for Domestic and Fire requirement. The top slab of this tank will be designed for vehicular movement. Part of this top slab will be kept lower than the finished level to allow for any MEP services from Ground level. The existing tanks shall be discarded once the new tanks are completed

III] Hurdles in Structural Design:

The path to assess the capacity of the building structure and ascertaining the number of possible additional floors was not easy because of non-availability of very important documents which could have simplified the whole process. Following were issues we found while carrying out the assessment.

- **Non-availability of structural reinforcement drawings**.

  As built RCC drawings were not available with the client and also not present in municipal records. We had to try fetching the same from the consultant who had designed the structure. However, there was no proper record available with the neither the consultant not the municipality. The available references were contacted however; the much-needed RCC reinforcement drawings were not received. Hence it was decided to prepare the complete RCC drawings by doing site measurements & visual survey.

- **Type of foundation is unknown**.

  Even though the drawings were not available, it was planned to take site measurements and note down the vertical columns and beam element and slab dimensions and sizes. However, the most important part of the building i.e., the foundation was not visible and it was equally difficult the access the foundation as the whole basement area was in use.

- **Grade of concrete and provide reinforcement is unknown**.

  Although the sizing of RCC beam column slab elements could be measured, their concrete grade, quality, strength and reinforcement inside were unknown.

IV] Solution:

After knowing the above-mentioned issues, the further action plan was prepared and implemented as follows.

- **Preparation of the structural framing plans**

  It was decided to prepare all structural drawings before we start with further the structural analysis and the design checks. Detailed site inspection was carried out and the framing plans for the entire building are prepared based on the site measurements. With the framing plan in place, all relevant information in regard to the column, beam slab sizes are available on the drawing.

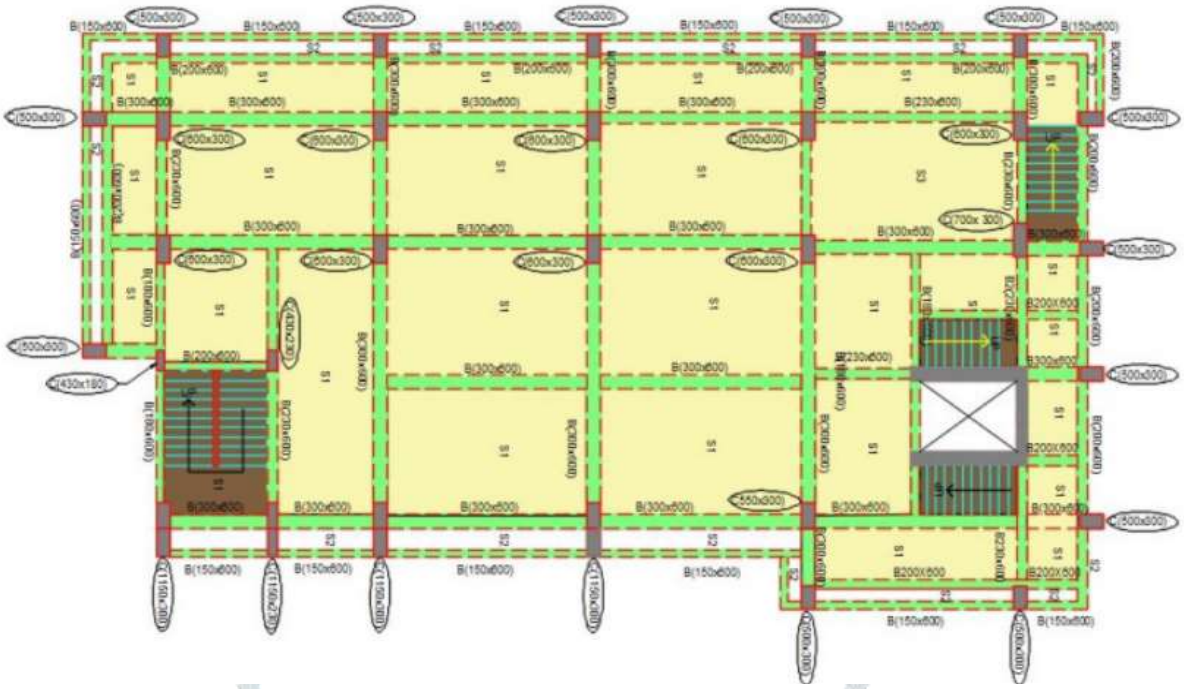

Figure: Framing Plan

- **Test done on structural members to assess the quality and grade of concrete**

  - **Non Destructive Test**

1. **Rebound Hammer test**

   It is a non-destructive testing apparatus, whereby the rebound of the spring driven mass is measured after its impact with the existing concrete surface.

Sr. No.	ID Mark of Member	Location	Grade of Concrete	Date of Casting	Age of Concrete (Days)	Avg. Rebound Index (After Mean Outliers)	Comp. Strength, (N/mm^2)	Direction of Rebound	Surface Condition
1	3rd Floor	C-1	NA	NA	NA	30.4	22.3	Horizontal	Dry
2	3rd Floor	C-2	NA	NA	NA	34.2	27.8	Horizontal	Dry
3	3rd Floor	S-1	NA	NA	NA	37.4	24.5	Vertical Up	Dry
4	1st Floor	C-3	NA	NA	NA	36.6	31.3	Horizontal	Dry
5	1st Floor	C-4	NA	NA	NA	32.6	25.5	Horizontal	Dry

Fig- Rebound Hammer test report

Conclusion- As the rebound number is between 30-40 the quality of concrete is good.

2. Ultra-sonic pulse velocity test

It is an in-situ, non-destructive test to check the quality of concrete, the strength and quality of concrete is assessed by measuring the velocity of an ultrasonic pulse passing through a concrete structure.

Sr. No.	ID Mark of Member	Location	Grade of Concrete	Date of Casting	Age of Concrete (Days)	Travel Path Length (mm)	Travel Time (µsec)	Actual Velocity (Km/sec)	Corrected Velocity (Km/sec) !	Probing Method	Surface Condition
1	3rd Floor	C-1	NA	NA	NA	400	132.6	3.02	3.52	Surface Probing	Dry
2	3rd Floor	C-2	NA	NA	NA	300	94.3	3.18	3.18	Cross Probing	Dry
3	3rd Floor	S-1	NA	NA	NA	400	145.4	2.75	2.75	Surface Probing	Dry
4	1st Floor	C-3	NA	NA	NA	400	131.3	3.05	3.55	Surface Probing	Dry
5	1st Floor	C-4	NA	NA	NA	350	124.9	2.80	2.80	Cross Probing	Dry

Fig- Ultra-sonic pulse velocity test

Conclusion- Concrete quality is reasonable

3. Half-cell potential meter test

It is the only corrosion monitoring technique for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete. It is used to determine the probability of corrosion within the rebar in reinforced concrete structures

Sr. No.	ID Mark	Location	Half Cell Potential Value in (-mV)
1	1st Floor	C-3	269
2	1st Floor	C-4	171

Fig- Half-cell potential meter test

Conclusion- Corrosion level is low

4. Rebar locator

The test is used to determine effective concrete cover, detect reinforcement. It is also very useful to locate rebars before hacking of concrete or extracting concrete cores.

- **Destructive Test**

1. Carbonation test

Carbonation testing provides a means which can determine the extent of carbon dioxide infiltration into the concrete.

2. Core cutting test

The Core Cutting was done to check the depth of footing and also the grade of the concrete

CONCRETE CORE COMPRESSIVE STRENGTH TEST RESULTS

Date of Testing : 08-09-21

Grade of Concrete : NA Source of Sample : NA

Sr No.	Specimen ID Mark	Date of Casting	Age of Specimen (Days)	Core Height (h) (mm) *	Core Dia (d) (mm)	Core Wt. (Kg) *	Cross sectional Area, mm^2	Max. Load (KN)	Actual Comp. Strength (N/mm2)	Correction Factor For Dia #	Correction Factor for (h/d) ratio $	Corrected Comp. Strength (After Dia & h/d Ratio) (N/mm2)	Equivalent Cube Comp. Strength (N/mm2) !
1	MID Foundation - 1	NA	NA	129.13	67.89	1.160	3620.4	66.90	18.48	1.06	0.989	19.38	24.2
2	MID Foundation - 2	NA	NA	128.49	67.43	1.125	3571.5	82.37	23.06	1.06	0.990	24.19	30.2
3	2nd Floor Slab - 1	NA	NA	112.18	67.83	1.022	3614.0	71.87	19.89	1.06	0.962	20.28	25.3
4	2nd Floor Slab - 1	NA	NA	129.43	67.68	1.180	3598.0	67.90	18.87	1.06	0.990	19.81	24.8
									Average Value			20.91	26.1

Fig- Core Test Results

Conclusion- Concrete grade can be considered as M25

V] Methodology:

There are several methods of strengthening the existing concrete some of them are mentioned below

- **Concrete Jacketing of existing columns** – when the size and the reinforcement provided in a structural member is insufficient due to change in loads or design then the existing member is surrounded with an additional thickness of concrete with additional required reinforcement. This enhances the size of the given member and thus increases the load carrying capacity of the existing member.
- **Steel Jacketing of existing columns** – here the jacketing is done using the steels plates and these steel plates are anchored to the existing column.

Actual methodology adopted to accommodate the change in design.

Although these are the prevalent methods of strengthening, the approach used in this project is slightly different. Here we have first checked that with the given reinforcement in the columns how much further load can be enhanced over them. So, we found that an additional floor can be taken over the existing terrace floor. The load compensation that was suggested for the additional floor was as below.

- Removal of the loft slabs on the 1st and 2nd floor.
- Removal of the terrace water proofing.