# Structural Design Basis Report-
## Faculty Residence, IISER Tirupati
## CE514L-Term Project

R.Vishwanath `CE20B024`

August-December 2023

## Contents

# 1 Introduction

This document specifies the details of the building along with the assumptions involved in the structural design and the basis of the assumptions. The scope of the submitted work includes only the software-based structural analysis of the model, design basis report and design calculation report presenting design, detailing and drawings of a few typical sections.

## 1.1 Details of the building

The proposed structural design is for the faculty residential building in the Indian Institutes of Science Education and Research (IISER) at Tirupati. The structural design satisfies the functional and non-structural constraints imposed by the architectural plan prepared by Arcop Associates Pvt Ltd. Based on the architectural drawings, the building is a G+3 building with an accessible roof. The height of the building is 18.2m. The horizontal dimensions of the building span 15.35×42.9m.

# 2 Structural System

The building is designed as a moment-resisting framed R.C.C. structure. Load transfer in these systems occurs through the transfer of moments and shear at the rigid joints. The design designated load path involves the transfer of live load in the building to the slab, then to the secondary beam, then to the primary beam, then to columns, and then to footings. The system is modelled in STAAD.Pro software developed by Bentley Systems. First-order analysis of the proposed system is performed through the software and submitted along with this report. The structure also includes shear walls(a grouped shear wall enclosing the lift and a discrete shear wall near the stairs). The roof of the building contains multiple split water tanks. Aerated autoclave bricks in modular dimensions are used as infill walls in the structure.

# 3 Assumptions involved in designs

Based on the architectural drawings all walls barring a few have a thickness of 200mm and all infill walls are considered to be of the same thickness. The contribution of the infill wall's bearing capacity is not considered. Load reduction for openings in the wall is not considered in the design. The water tanks on the roof are considered to be full. The safe bearing capacity of soil at the site is assumed as 200KPa. The site is assumed to be in Bangalore(seismic zone-II and the period of building is less than 0.4s. (Which is untrue but is assumed to simplify the dynamic load induced by an earthquake as equivalent static load). The viscous damping coefficient of the building is assumed 5%.

# 4 Method of Design and Analysis

In the analysis, the beams, and columns are idealized as line elements, the footings are assumed fixed and the slabs are modelled as plates. The analysis is performed for a combination of vertical load(dead load and live load) and horizontal load(only earthquake load) based on IS 456 2000 and IS 1893 2016. Equivalent static load analysis is performed to distribute the dynamic earthquake loads along the vertical profile of the building.

# 5 Design Loads

## 5.1 Discrete Loads

The value for the discrete unit load is obtained from IS 875. The following discrete loads are considered

- Dead Load(DL)
  - Structural Elements($\gamma_{R.C.C} = 25KN/m^3$)
  - Masonry Infill-($\gamma_{A.A.C} = 7.5KN/m^3$)
  - Finish load-($FL = 1KN/m^2$)
- Live Load(LL)[Residential buildings]
  - Habitable spaces-($FL = 2KN/m^2$)
  - Accessible roof-($FL = 2KN/m^2$)
  - Stairs-($FL = 3KN/m^2$)
- Earthquake Load
  - $EL_x$ and $EL_{-x}$
  - $EL_z$ and $EL_{-z}$

## 5.2 Load Combinations

The following load combinations based on IS 456 and IS 1893 are considered for analysis and the envelope of responses is considered for design.

- 1.5 DL + 1.5 LL
- 1.2 DL + 1.2 LL $\pm$1.2EL$_x$
- 1.2 DL + 1.2 LL $\pm$1.2EL$_z$
- 1.5 DL + 1.5 LL
- 1.2 DL + 1.2 LL $\pm$1.2EL$_x$
- 1.2 DL + 1.2 LL $\pm$1.2EL$_z$
- 1.5 DL $\pm$1.5EL$_x$
- 1.5 DL $\pm$1.5EL$_z$
- 0.9 DL $\pm$1.5EL$_x$
- 0.9 DL $\pm$1.5EL$_z$

# 6 Design Parameters

## 6.1 Concrete cover

IS 456 suggests clear cover based on the desired fire resistance and the severity of exposure(to substances causing early deterioration of structure) the member may be expected to handle. A moderate exposure level is considered with nominal cover of 30mm.

## 6.2 Grade of Concerete

It is assumed that all the members are to be constructed only with M35 concrete.

### 6.3 Reinforcement

Fe500 grade rebar of variable diameter is used as rebar in the structure. And the reinforcement level in each section is to be checked and adjusted to satisfy minimum and maximum threshold requirements suggested by IS 456.

## 7 Servicability and Detailing

To meet serviceability requirements for service loads the flexural members were designed to satisfy the following conditions.

$$\Delta_{DL+LL} + \Delta_{shrg} + \Delta_{crp} < span/250 \tag{1}$$

$$\Delta_{LL} + \Delta_{shrg} + \Delta_{crp} < min[span/350, 20mm] \tag{2}$$

where $\Delta_x$ corresponds to deflection due to x.
Appropriate ductility and serviceability-based detailing practices are implemented in structural drawings.

## 8 References

The following references were used in the analysis, design and preparation of drawings of the building.


1. IS 456-2000 :Code of Practice for Plain & Reinforced Concrete
2. IS 875 Part 1,Part 2-1987& 3-2015: Code of Practice for Design loads (other than Earthquake)for Building and structures
3. SP 16 : Design Aid to IS 456-2000
4. IS 1893-2016:Criteria for Earthquake Resistant Design of structures
5. IS 13920-2016:Ductile Detailing of reinforced Concrete Structures subjected to seismic forces