Structural Analysis and Design of Raw Material Proportioning Building In Cement Industry

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Abstract - The material proportioning hopper is a crucial component in various industrial processes, facilitating precise and efficient blending of multiple materials in predetermined ratios. This equipment plays a pivotal role in industries such as manufacturing, construction, and agriculture, where accurate material mixing is essential for quality and consistency in end products. Key features include a robust structure capable of handling diverse materials, from powders to granular substances, and a user-friendly interface for easy operation and customization of material proportions. Additionally, the material proportioning hopper is designed with considerations for safety, maintenance, and environmental impact, adhering to industry standards and regulations. The material proportioning hopper emerges as a vital tool in modern industrial processes, contributing to enhanced efficiency, product quality, and overall operational excellence. This abstract provides a glimpse into the innovative features and functionalities that make the material proportioning hopper an indispensable asset in industries reliant on precise material blending.

Key Words: raw material, proportioning hopper, cement industry, Manufacturing cement.

1.INTRODUCTION

The Material Proportioning Hopper (MPH) plays a pivotal role in various industrial applications, ensuring accurate and efficient blending of multiple materials to meet specific production requirements. This abstract provides an detail overview of the significance, functionalities, and advancements in Material Proportioning Hopper technology. The MPH serves as a critical component in industries such as pharmaceuticals, food processing, cement production, and chemical manufacturing, where precise material blending is essential for achieving desired product characteristics. This device enables the controlled dispensing of raw materials into a mixing or processing system, influencing the quality and consistency of the final product. Key features of modern Material Proportioning Hoppers include advanced sensors, automation, and feedback mechanisms that enhance accuracy and reliability. These hoppers are designed to accommodate a variety of materials with different flow properties, ensuring uniform proportions and minimizing waste.The softwares used in this design are

1. AutoCAD
2. STAAD PRO Connect Edition

2. Literature Review

IS:875 (Part 1) -1987 It gives an outline of Dead Loads in the Indian Standard Code Of Practice For Design Loads (Other Than Earthquake) For Buildings and Structures. All permanent parts of the structure contribute to the dead loads, including walls, partitions, floor finishes, false ceilings, false floors, and other permanent features in the buildings. Calculating dead loads involves considering the dimensions of different components and their individual weights. The unit weight for plain concrete is around 24 KN/m3 and for reinforced concrete made with sand and gravel or crushed natural stone aggregate is also approximately 24 KN/m3.

IS: 1893 (Part1) -2002 The Indian Standard Criteria for Earthquake Resistant Design of Structures,andcfocuses on seismic loads assessment and earthquake-resistant building design. These guidelines apply to various structures like buildings, elevated structures, industrial complexes, bridges, concrete masonry, and earth dams. Temporary features such as scaffolding and excavations are exempt from earthquake force considerations.

ASCE 7-05 It gives us the smallest amount of load needed for building designs. Two ways to design are allowed: allowable stress design (ASD) and strength design. Designers can pick either one. Roofs usually use ASD. ASCE 7-05 has one map for wind speeds. Each building category gets an importance factor & a wind-load factor applied for final wind loads. In this version, ASD's wind-load factor is 1.0 and strength design's is 1.6. Calculate roof wind-uplift loads by multiplying ultimate wind loads by 1.0 and the right safety factor.

CHAPTER 3
DESIGN AND METHODOLOGY

A structure can be defined as a body, which can resist the applied loads without appreciable deformations. Civil engineering structures are created to serve soma specific like, Human habitation, transportation, bridges, storage etc. in safe and economical way. A structure is assembling of individual elements like pinned elements (truss elements), beam elements, column, shear wall slab able or arch. Structural engineering is concerned with the planning, designing and the construction of structures. Structural analysis involves the determination of the forces and displacements of the structures or components of a structure that make up the structural system. The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

Designing a preheater building involves several key considerations to ensure its efficiency, safety, and functionality. Below is a general methodology that can be followed in designing a Material Proportioning building:

3.1 Objectives and Requirements Definition:

Clearly outline the objectives for the hopper building, including the type of placing process it will support and the desired capacity. Establish specific requirements like temperature ranges, material handling capabilities, and safety standards.

3.2 Site Selection:

When choosing a location for the Material proportioning hopper building (of course), consider factors such as proximity to the main processing unit, accessibility, and environmental impact. It matters.

3.3 Regulatory Compliance:

It is crucial to understand and comply with local building codes, safety regulations, and environmental standards related to the construction and operation of the hopper building.

3.4 Process Analysis:

Take a deep dive into the proportioning process with a focus on heat requirements, material flow, and potential hazards. And don't forget to pick the right kind of preheater (whether it's direct-fired, indirect-fired, or electric) that meets your process needs.

3.5 Equipment Selection:

Equipment selection should be based on energy efficiency, maintenance requirements, and equipment longevity. Options may include rotary kilns, fluidized bed preheaters, or other specialized equipment.

3.6 Structural Design:

Structural design plays a crucial role in ensuring a robust and safe building structure that can support the proportioning equipment. Factors like seismic design, wind loads, and foundation design must be taken into consideration.

3.7 Ventilation and Emission Control:

Efficient ventilation systems are necessary to control dust and fumes generated during the placing process. Additionally, emission control devices should be installed to comply with environmental regulations and safeguard air quality.

3.8 Safety Measures:

Safety measures cannot be compromised. The design of the preheater building should prioritize safety with features like emergency exits, fire suppression systems, and safety barriers in place to ensure compliance with occupational health and safety standards.

3.9 Utilities and Services:

Planning for utility connections is key. This includes considerations for power supply, water supply, gas lines, as well as integration of automation and control systems for efficient operation.

3.10 Construction and Commissioning:

During construction and commissioning phases, strict supervision is essential to ensure adherence to approved designs. Thorough testing and commissioning of the hopper and associated systems are necessary to verify their performance.

Methodology

In terms of methodology followed for creating the model: load calculations are done in accordance with Indian standard code procedures for industrial structures. Each step from modelling to loading analysis is depicted step by step format, By meticulously adhering to these steps in an authoritative manner throughout each phase of construction and operation ensures a successful outcome for the preheater building project.

Model development

Loadings

Load combinations

Analysis Procedure

Design procedure.

CHAPTER 4
MODELING

4.1 General Details

The structural model details of preheater towers for the RCC are listed, which include the cross-sectional data of beams, columns, slab thickness plan, and elevation data of the model shear wall placement for the RCC model and the different materials used for this modelling and the step by step development of the model using the STAAD pro software is represented.

All RCC structures, foundations, walls etc. shall be carried out by limit state method with appropriate partial safety factors over characteristic strength and characteristic loads. However, the parts of such structures not coming in contact with liquid may be designed according to BS EN 1992-1

Civil design shall be done as per the relevant American code.

The analysis and design shall be done by using STAAD PRO software. The 3D model of the structure shall be generated in STAAD.

Air slide Gallery: It is a truss system consisting of a bottom chord and top chord connected by vertical members and bracings which will together act as a girder. Air slide short supports will be supported cross beam directly. The top chord level and walkway level consist of horizontal bracings.

Gallery will transfer all loads to building/trestles. Gallery end portal will have roller supports at the transfer tower & pinned at trestles.

Trestles: It will be 4-legged or 2-legged braced systems. All horizontal loads (along air slide direction) due to wind and earthquake will be transferred to the foundation through 2 or 4 legged trestles. The wind load acting on the single trestle also been transferred to 4 legged trestles.

To obtain the results for General Alignment when subjected to uniform condition.

Use of software such as STADD may be adopted to obtain bending and shearing data of the constructed frame by loading.

Following load combinations will be adopted for structure design as per ASCE 7-05.

Dead load

Earthquake load

Load due to lateral earth pressure

Live load

Roof Live Load

Wind Load`

Limiting Vertical and Horizontal deflection for structural members will not exceed the recommendations of relevant code and standards. MBMA metal building system manual provisions shall prevail.

Factor of safety for foundation/structure shall be as per American code:Over turning minimum FOS against overturning = 1.5

Sliding minimum FOS against overturning = 1.5

SBC Values are to be followed as per soil report mentioned SBC value / Soil subgrade value/ Foundation placing depth for each individual building.Plant Structures/Buildings

Dead Load (DL)

Self-weight of structure- self weight will be calculated by STAAD with the help of Command "SELF WEIGHT" Input Value 1.0 for RCC & 1.15 for Steel structures.

Cheqd. Plate (6mm Thick) = 60 kg/m2.

Grating (30 Thick) = 30 kg/m2

Cladding (including Purlins & fasteners) = 20 kg/m2

Cement (Density) = 1600 kg/m3Equipment dead load = As per Mech. GA

Fixed Ladders with rungs = 1.33 KN

Live load on maintenance platform = 500 kg/m2

Steel/RCC Platforms where equipment is not located = 500 kg/m2

Steel/RCC Platforms where equipment is located = 500 kg/m2

Live load on ground floor = 2000 kg/m2

Live load on Silo roof = 250+50 (Dust Load)

Stair = 500 kg/m2

Roof = 200 kg/m2

CHAPTER 5
STADD MODELING & DESIGN

Isometric view:

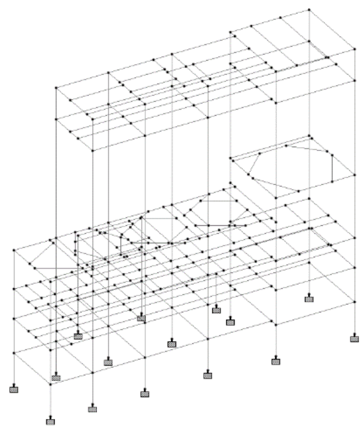


Figure 1 Isometric view of RMPH

Node Number:

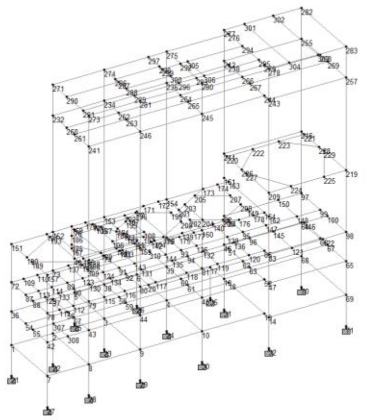


Figure 2 Node Numbering of RMPH

Beam Number

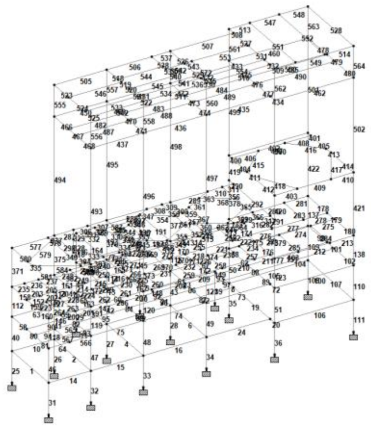


Figure 3 Beam numbering of RMPH

Symbols & Notation:

DL = DEAD LOAD & EQUIPMENT DEAD LOAD

LL = LIVE LOAD

WL = WIND LOAD

SL = SEISMIC LOAD

DL EQP = EQUIPMENTAL DEAD LOAD

Service Load Combinations:

1. DL
2. LL
3. SL
4. WIND LOAD

Strength Load Combinations:

Load Combinations as per ASCE –7 -05 and IS - 456

1.5 DL + 1.5 DL EQP + 1.5 LL

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 WL +X

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 WL -X

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 WL +Z

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 WL -Z

1.2 DL + 1.2 DL EQP + 1.2 LL - 1.2 WL +X

1.2 DL + 1.2 DL EQP + 1.2 LL - 1.2 WL -X

1.2 DL + 1.2 DL EQP + 1.2 LL - 1.2 WL +Z

1.2 DL + 1.2 DL EQP + 1.2 LL - 1.2 WL -Z

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 SL +X

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 SL +Z

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 SL -X

1.2 DL + 1.2 DL EQP + 1.2 LL + 1.2 SL -Z

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5 WL +X

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5 WL -X

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5 WL +Z

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5 WL -Z

1.5 DL + 1.5 DL EQP + 1.5 LL - 1.5WL +X

1.5 DL + 1.5 DL EQP + 1.5 LL - 1.5WL -X

1.5 DL + 1.5 DL EQP + 1.5 LL - 1.5WL +Z

1.5 DL + 1.5 DL EQP + 1.5 LL - 1.5WL -Z

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5SL +X

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5SL +Z

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5SL -X

1.5 DL + 1.5 DL EQP + 1.5 LL + 1.5 SL -Z

0.9 DL + 0.9 DL EQP + 1.5 WL +X

0.9 DL + 0.9 DL EQP + 1.5 WL -X

0.9 DL + 0.9 DL EQP + 1.5 WL +Z

0.9 DL + 0.9 DL EQP + 1.5 WL -Z

0.9 DL + 0.9 DL EQP - 1.5 WL +X

0.9 DL + 0.9 DL EQP - 1.5 WL -X

0.9 DL + 0.9 DL EQP - 1.5 WL +Z

0.9 DL + 0.9 DL EQP - 1.5 WL -Z

0.9 DL + 0.9 DL EQP + 1.5 SL +X

0.9 DL + 0.9 DL EQP + 1.5 SL +Z

0.9 DL + 0.9 DL EQP - 1.5 SL +X

0.9 DL + 0.9 DL EQP - 1.5 SL +Z

Loads & Load Combinations:

Load specification / data considered as described below,

Load Parameters:

DL- Dead Load

Dead Load of structural Element.

Loads

• Slab Dead load = 150mm thk. = 3.75 kN/m2

• Slab Dead load = 200mm thk. = 5.00 kN/m2

• Slab Dead load = 300mm thk. = 7.50 kN/m2

• Floor Finish Load = 1.5 kN/m2 (consider for lightly loaded & Moveable Equipment)

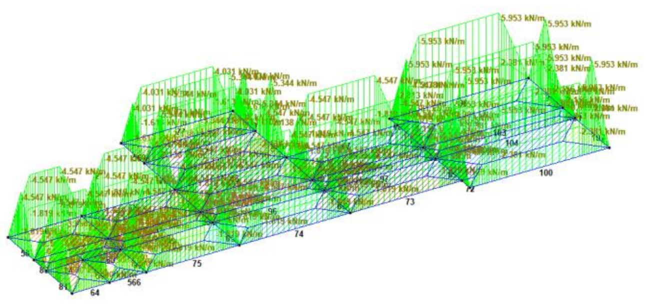


Figure 6 Dead load at plan 5.8m

Plan at 3.000M LVL

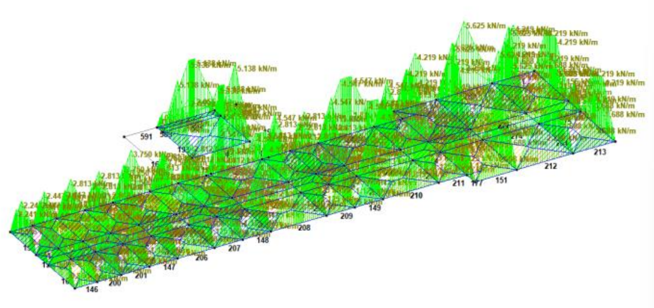


Figure 4Dead load at plan 5.8m

Plan at 5.800M LVL

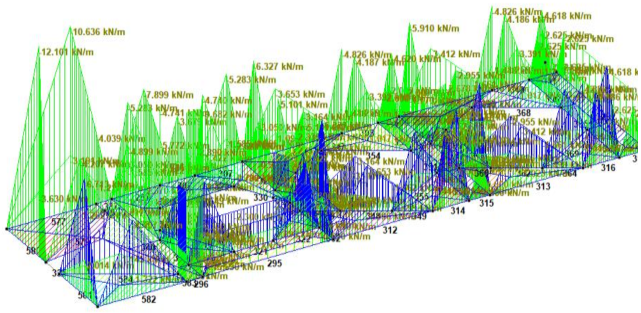


Figure 5 Dead load at plan 9.5m

Plan at 9.500M LVL

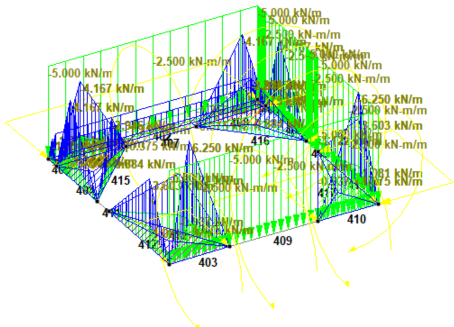


Figure 6 Dead load at plan 11.8m

Plan at 11.800M LVL

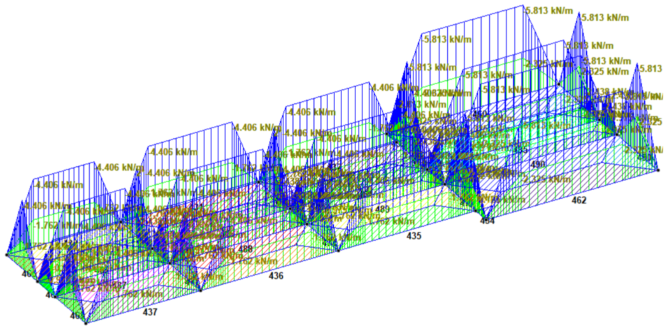


Figure 7 Dead load at plan 20.8m

Plan at 20.800M LVL

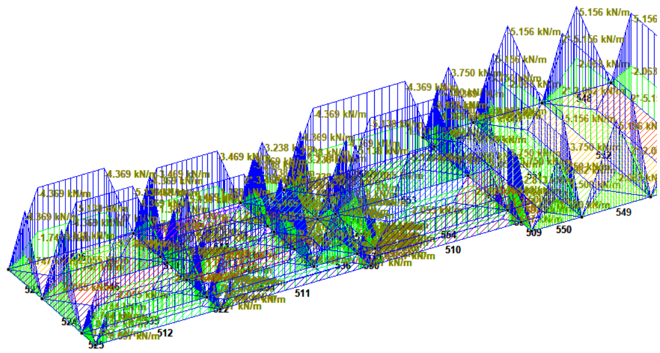


Figure 8 Dead load at plan 23.8m

Plan at 23.800M LVL

DL: EQP- Equipment Dead Load

Equipment Dead Load taken from GA drawing

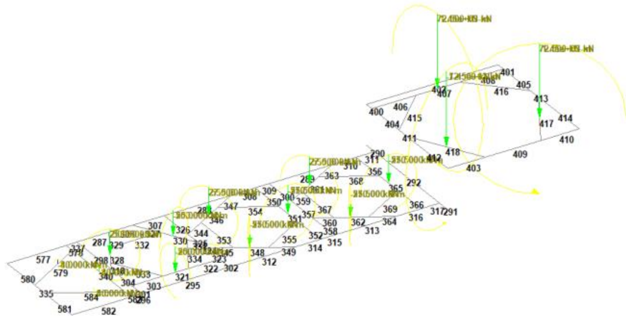


Figure 9 Equipment Dead load at plan 9.8 and 11.8 m

EQUIPMENT LOAD AT +9.800 & +11.800 M LVL

LL- Live Load / Impose Load

As per Design Basis Report, Live Loads is considered 500 kg/sqm = 5.0 kN/sqm.

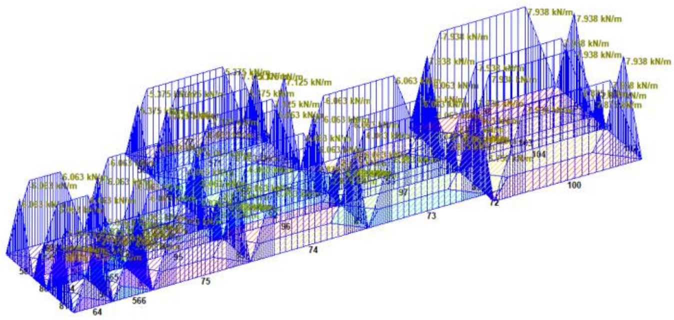


Figure 10 Live load at plan 3m

Plan at 3.000M LVL

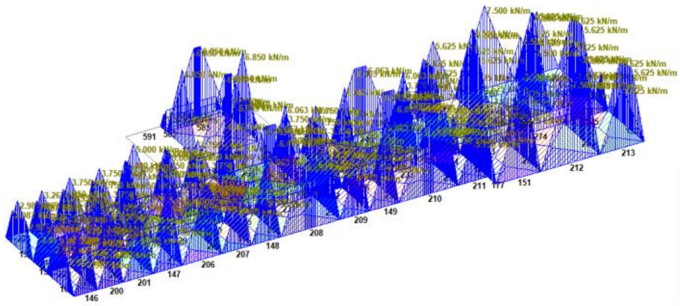


Figure 11 Live load at plan 5.8m

Plan at 5.800M LVL

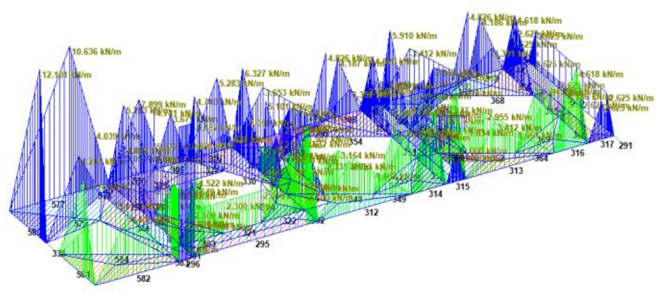


Figure 12 Live load at plan 9.5m

Plan at 9.500M LVL

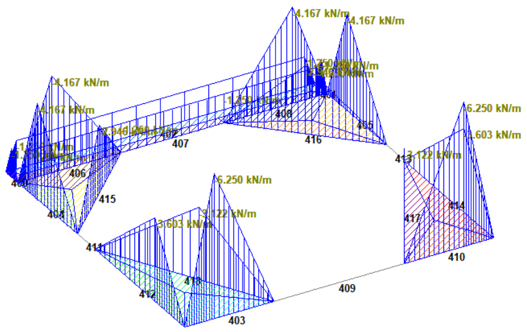


Figure 13 Live load at plan11.9 m

Plan at 11.9M LVL

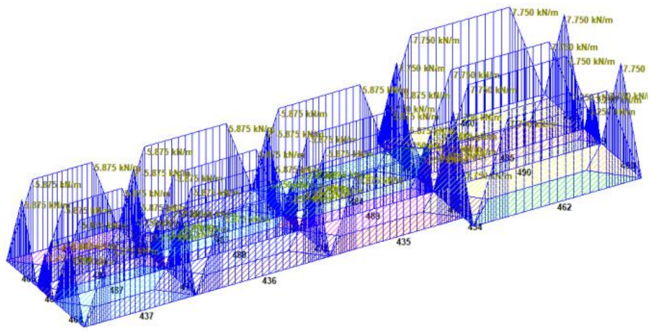


Figure 14 Live load at plan 20.8m

Plan at 20.8M LVL

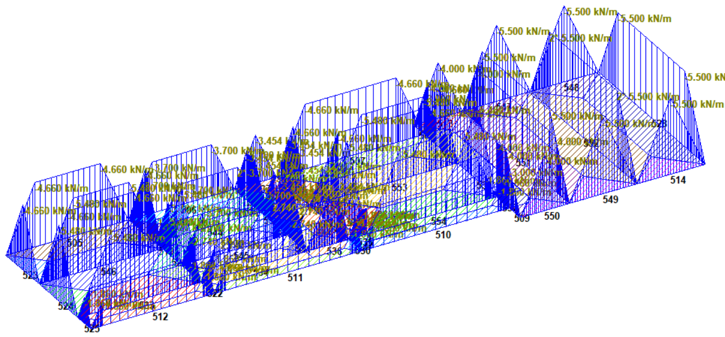


Figure 15 Live load at plan23.8 m

Plan at 23.8M LVL

WL- Wind Load

Wind loads shall be considered as partial enclosed Building as per ASCE 7-05 with Basic wind velocity as 45 kmph.

WL- Wind Load

Wind loads shall be considered as partial enclosed Building as per ASCE 7-05 with Basic wind velocity as 45 kmph.

WIND CALCULATION BASED ON (ASCE-7-05)

BASIC INFORMATION OF BUILDING

HEIGHT OF STRUCTURE =	29.50	m
LENGTH OF STRUCTURE =	28.50	m
WIDTH OF STRUCTURE =	7.50	m

WIND CALCULATION

AS PER CLAUSE 6.5.10. VELOCITY PRESSURE (qz). $q_z = 0.613 K_z K_{zt} K_d V^2 I \ (N/m^2)$

WHERE. (m/s)
V = BASIC WIND VELOCITY
qz = VELOCITY WIND PRESSURE AT HEIGHT z ABOVE GROUND LEVEL
I = IMPORTANCE FACTOR (TABLE 6.1)
Kz = VELOCITY EXPOSURE COEFFICIENT AS PER HEIGHT (TABLE 6.3)
Kd = WIND DIRECTIONALITY FACTOR AS PER TYPE OF STRUCTURE (TABLE 6.4)
Kzt = TOPOGRAPHIC FACTOR

AS PER GIVEN DATA.

V=	45	m/s
I =	1	
Kd =	1	
Kzt =	1	

AS PER CLAUSE 6.5.13.3. WIND PRESSURE ON CLADDED ELEMENT. $p = q_h G C_p$

WHERE. G = GUST FACTOR
Cp = EXTERNAL PRESSURE COEFFICIENT

CLACULATION OF GUST FACTOR (G) FOR RIGID STRUCTURE.

$$G = 0.925\left\{\frac{1 + 1.7 I_z \sqrt{g_q^2 Q^2 + g_r^2 R^2}}{1 + 1.7 g_v I_z}\right\}$$

$$I_z = c\left(\frac{10}{\bar{z}}\right)^{\frac{1}{6}}$$

WHERE. z = EQUIVALENT HEIGHT OF STRUCTURE

z =	17.7	m
c =	0.2	
Iz =	0.182	

WHERE. l AND ϵ ARE CONSTANTS LISTED IN TABLE 6.2

$$L_{\bar{z}} = \ell\left(\frac{\bar{z}}{10}\right)^{\epsilon}$$

l =	152.4	m
ϵ =	0.20	
Lz =	170.836	

$$Q = \sqrt{\frac{1}{1 + 0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}}$$

IN X-DIRECTION

B =	28.5	
Q =	0.871	

IN Z-DIRECTION

B =	7.50	M
Q =	0.898	

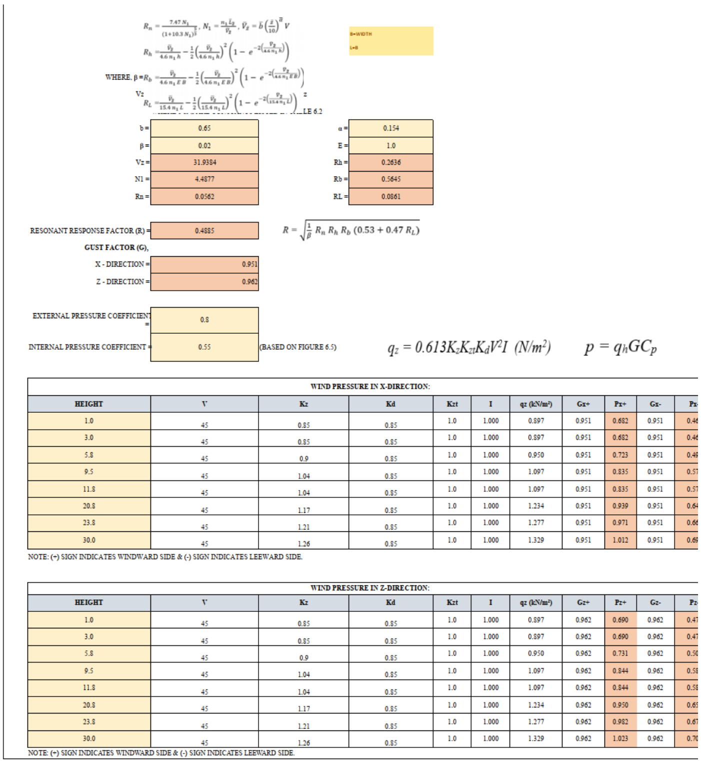
$$g_r = \sqrt{2\ln(3600 n_1)} + \frac{0.577}{\sqrt{2\ln(3600 n_1)}}$$

WHERE. n1 = BUILDING NATURAL FREQUENCY

n1 =	0.8	
gr =	4.147	

$$R = \sqrt{\frac{1}{\beta} R_n R_h R_b (0.53 + 0.47 R_L)}$$

WHERE.



$$R_n = \frac{7.47 N_1}{(1+10.3 N_1)^{\frac{5}{3}}},\; N_1 = \frac{n_1 \bar{L}_{\bar{z}}}{\bar{V}_{\bar{z}}},\; \bar{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{10}\right)^{\bar{\alpha}} V$$

$$R_h = \frac{\bar{V}_{\bar{z}}}{4.6 n_1 h} - \frac{1}{2}\left(\frac{\bar{V}_{\bar{z}}}{4.6 n_1 h}\right)^2\left(1 - e^{-2\left(\frac{\bar{V}_{\bar{z}}}{4.6 n_1 h}\right)}\right)$$

WHERE, β = $R_b = \frac{\bar{V}_{\bar{z}}}{4.6 n_1 E B} - \frac{1}{2}\left(\frac{\bar{V}_{\bar{z}}}{4.6 n_1 E B}\right)^2\left(1 - e^{-2\left(\frac{\bar{V}_{\bar{z}}}{4.6 n_1 E B}\right)}\right)$

Vz

$R_L = \frac{\bar{V}_{\bar{z}}}{15.4 n_1 L} - \frac{1}{2}\left(\frac{\bar{V}_{\bar{z}}}{15.4 n_1 L}\right)^2\left(1 - e^{-2\left(\frac{\bar{V}_{\bar{z}}}{15.4 n_1 L}\right)}\right)$ z ...LE 6.2

B=WIDTH
L=B

b =	0.65	α =	0.154
β =	0.02	E =	1.0
Vz =	31.9384	Rh =	0.2636
N1 =	4.4877	Rb =	0.5645
Rn =	0.0562	RL =	0.0861

RESONANT RESPONSE FACTOR (R) = 0.4885 $R = \sqrt{\frac{1}{\beta} R_n R_h R_b (0.53 + 0.47 R_L)}$

GUST FACTOR (G),
X - DIRECTION = 0.951
Z - DIRECTION = 0.962

EXTERNAL PRESSURE COEFFICIENT = 0.8
INTERNAL PRESSURE COEFFICIENT = 0.55 (BASED ON FIGURE 6.5)

$q_z = 0.613 K_z K_{zt} K_d V^2 I \;(N/m^2)$ $p = q_h G C_p$

WIND PRESSURE IN X-DIRECTION:

HEIGHT	V	Kz	Kd	Kzt	I	qz (kN/m²)	Gx+	Px+	Gx-	Px-
1.0	45	0.85	0.85	1.0	1.000	0.897	0.951	0.682	0.951	0.46
3.0	45	0.85	0.85	1.0	1.000	0.897	0.951	0.682	0.951	0.46
5.8	45	0.9	0.85	1.0	1.000	0.950	0.951	0.723	0.951	0.49
9.5	45	1.04	0.85	1.0	1.000	1.097	0.951	0.835	0.951	0.57
11.8	45	1.04	0.85	1.0	1.000	1.097	0.951	0.835	0.951	0.57
20.8	45	1.17	0.85	1.0	1.000	1.234	0.951	0.939	0.951	0.64
23.8	45	1.21	0.85	1.0	1.000	1.277	0.951	0.971	0.951	0.66
30.0	45	1.26	0.85	1.0	1.000	1.329	0.951	1.012	0.951	0.69

NOTE: (+) SIGN INDICATES WINDWARD SIDE & (-) SIGN INDICATES LEEWARD SIDE.

WIND PRESSURE IN Z-DIRECTION:

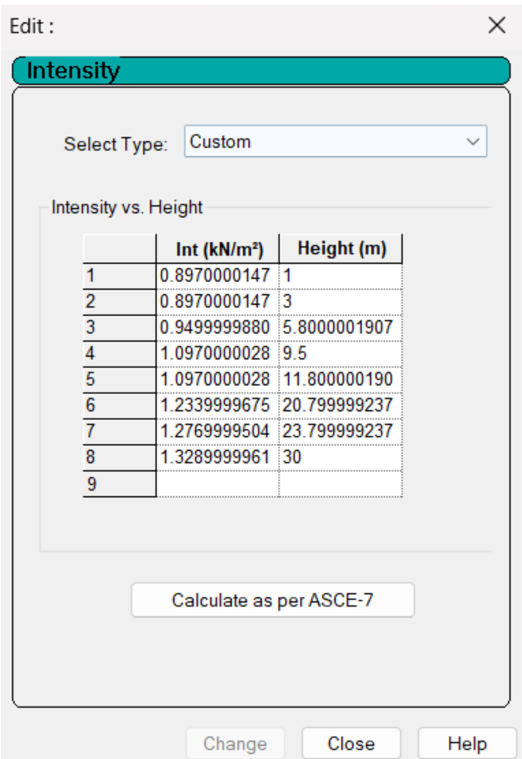
HEIGHT	V	Kz	Kd	Kzt	I	qz (kN/m²)	Gz+	Pz+	Gz-	Pz-
1.0	45	0.85	0.85	1.0	1.000	0.897	0.962	0.690	0.962	0.47
3.0	45	0.85	0.85	1.0	1.000	0.897	0.962	0.690	0.962	0.47
5.8	45	0.9	0.85	1.0	1.000	0.950	0.962	0.731	0.962	0.50
9.5	45	1.04	0.85	1.0	1.000	1.097	0.962	0.844	0.962	0.58
11.8	45	1.04	0.85	1.0	1.000	1.097	0.962	0.844	0.962	0.58
20.8	45	1.17	0.85	1.0	1.000	1.234	0.962	0.950	0.962	0.65
23.8	45	1.21	0.85	1.0	1.000	1.277	0.962	0.982	0.962	0.67
30.0	45	1.26	0.85	1.0	1.000	1.329	0.962	1.023	0.962	0.70

NOTE: (+) SIGN INDICATES WINDWARD SIDE & (-) SIGN INDICATES LEEWARD SIDE.

Figure 16 Wind load calculations as per AISC

- **Wind load input data in STADD:**

Intensity in X-Direction



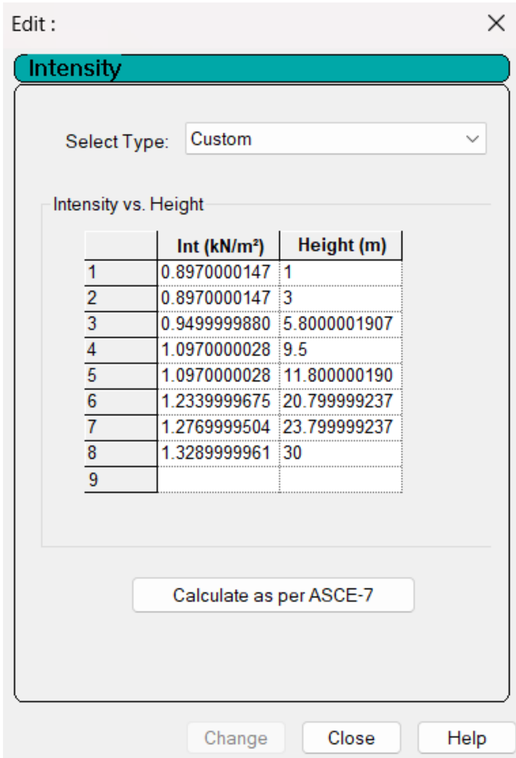
Edit :
Intensity
Select Type: Custom
Intensity vs. Height

	Int (kN/m²)	Height (m)
1	0.8970000147	1
2	0.8970000147	3
3	0.9499999880	5.8000001907
4	1.0970000028	9.5
5	1.0970000028	11.800000190
6	1.2339999675	20.799999237
7	1.2769999504	23.799999237
8	1.3289999961	30
9		

Calculate as per ASCE-7
Change Close Help

Figure 17Stadd input for wind load 1

- Intensity in Z-Direction



Edit :
Intensity
Select Type: Custom
Intensity vs. Height

	Int (kN/m²)	Height (m)
1	0.8970000147	1
2	0.8970000147	3
3	0.9499999880	5.8000001907
4	1.0970000028	9.5
5	1.0970000028	11.800000190
6	1.2339999675	20.799999237
7	1.2769999504	23.799999237
8	1.3289999961	30
9		

Calculate as per ASCE-7
Change Close Help

Figure 18Stadd input for wind load 2

- **Wind Load in +X-Direction.**

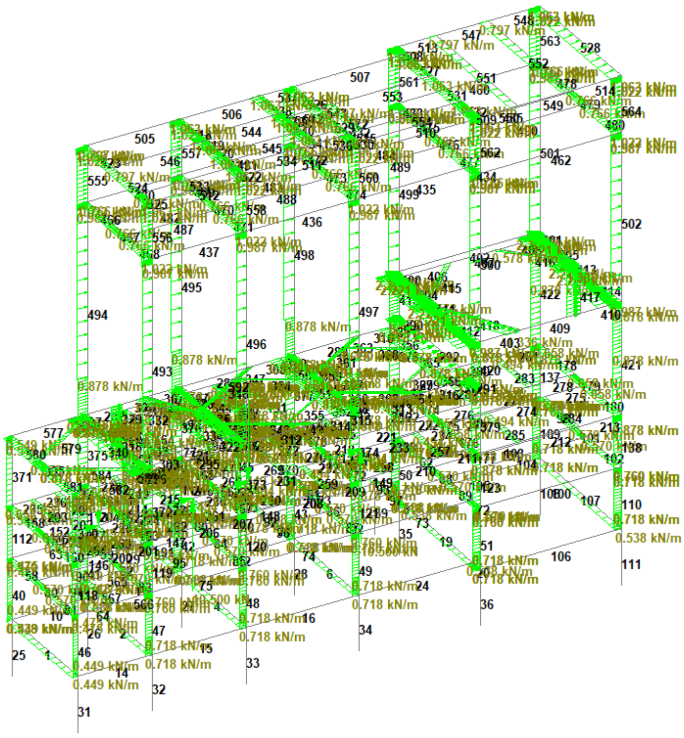


Figure 19Wind load in x direction

Wind Load in -X-Direction.

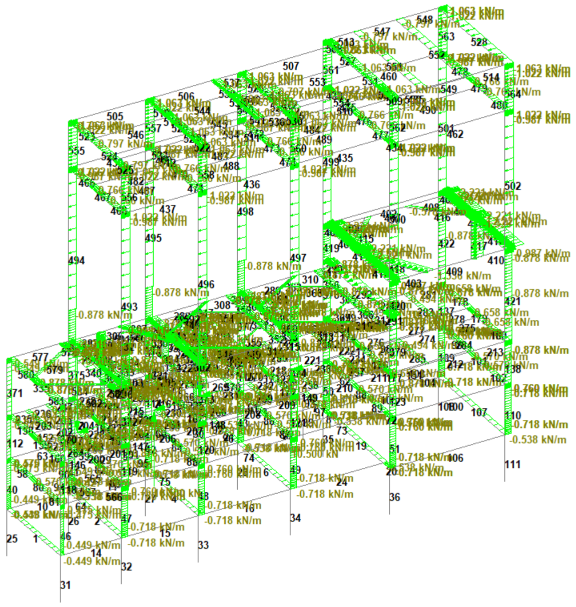


Figure 20Wind load in- x direction

Wind Load in -Z-Direction.

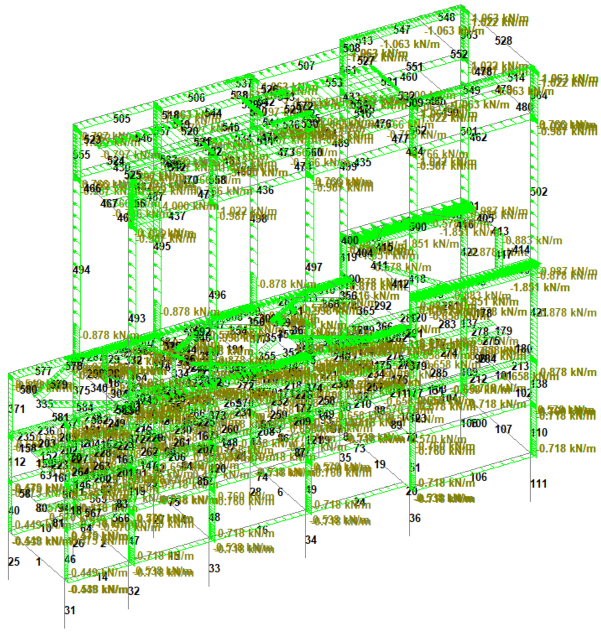


Figure 22Wind load in -z direction

Wind Load in +Z-Direction.

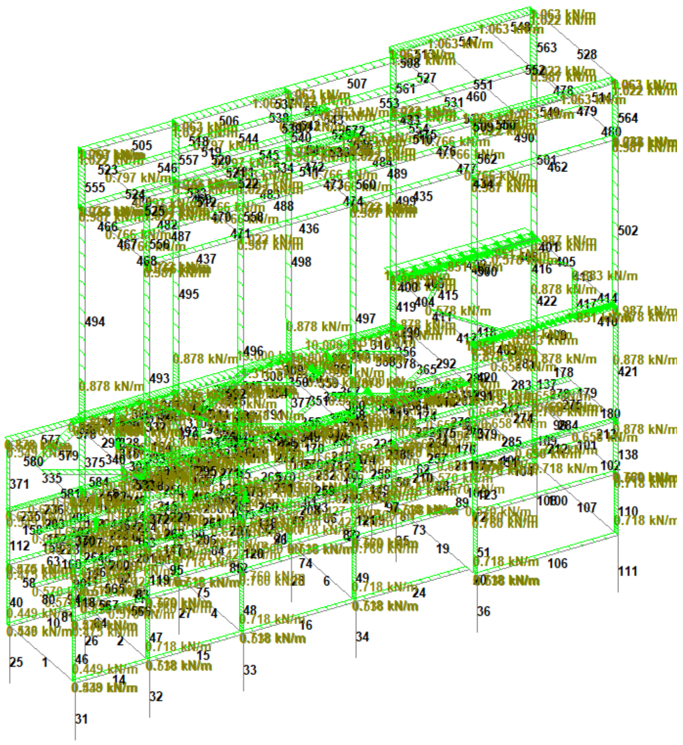


Figure 21Wind load in z direction

SL- Seismic Load

Seismic Load for Building as per IS IS-875-part-3-2015

Seismic Load input Data in STADD

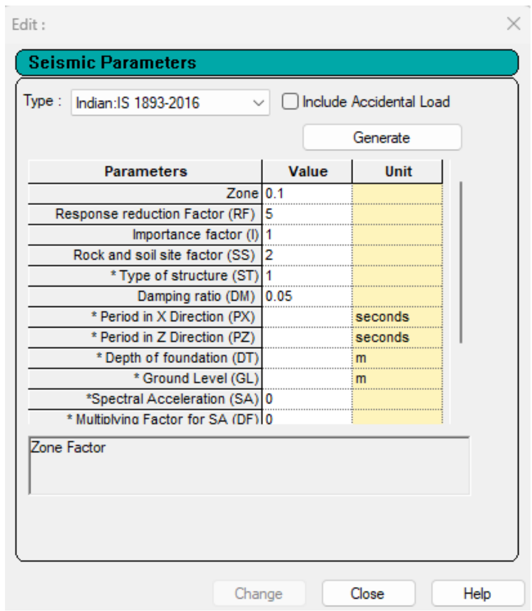


Figure 23Stadd input of seismic data

Seismic Load in X – Direction

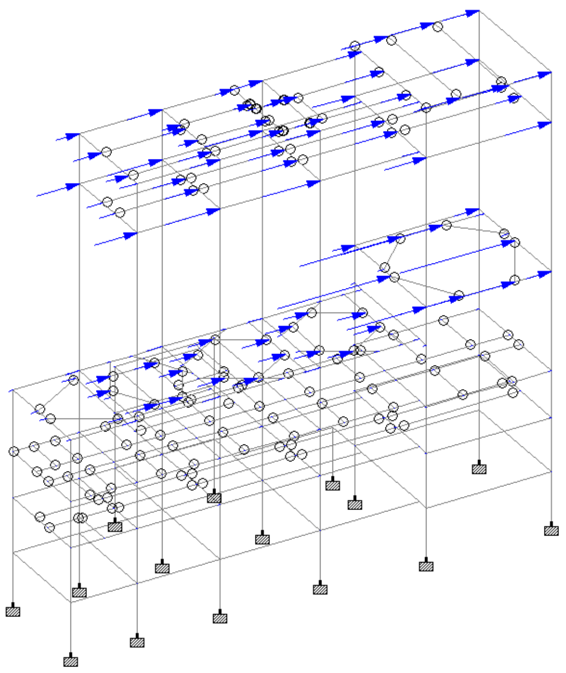


Figure 24 Seismic load in x direction

Seismic Load in Y – Direction

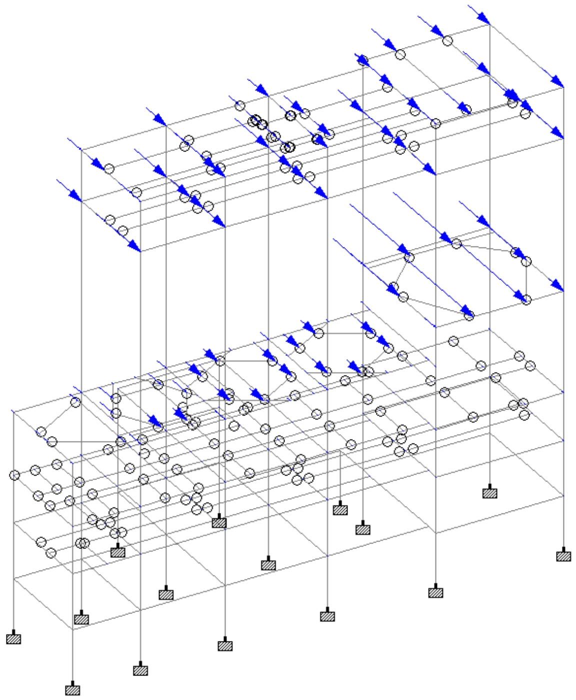


Figure 25 Seismic load in z direction

Analysis window

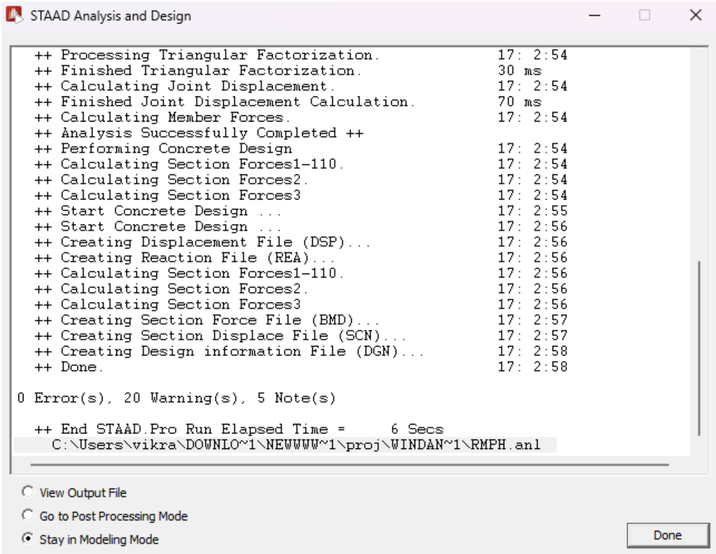


Figure 26 Post analysis data

Since there are no errors and only warnings we can proceed further for the analysis with caution.

CHAPTER 6
DESIGN

Design of slab :

Crossbeams are most extensively used structural rudiments forming bottom and roof of structure. Arbor supports substantially transverse cargo and transfer them to supports by bending conduct in both the directions. On the base of gauging direction.

Design types of slab

The design for slab is done based on two types

One way slab

Two way slab

Design of Beams of structure :

The Beams are designed into following types, They are

Singly reinforced beams

Doubly reinforced beams

Beam Design by STAAD PRO

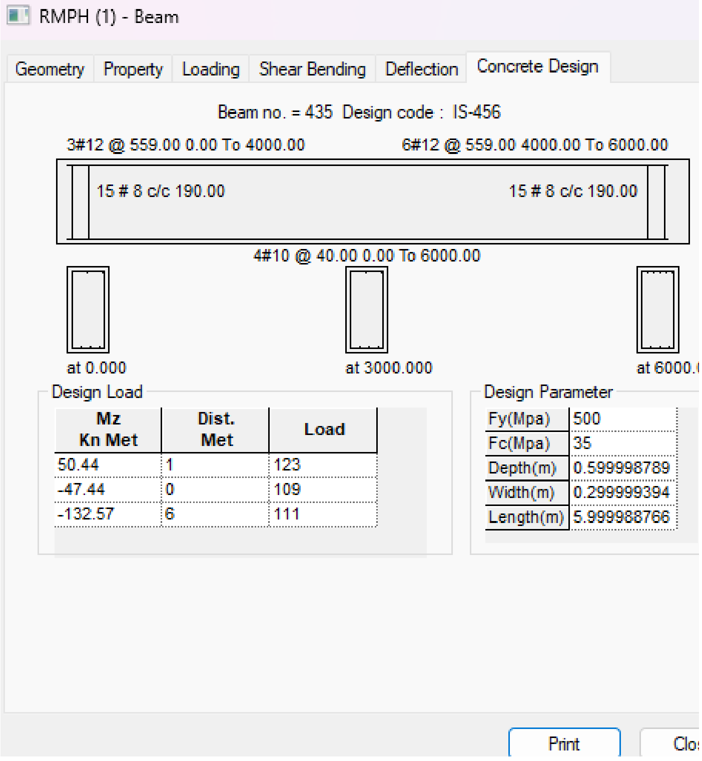


Figure 27Detailing of Beam no 435 in stadd

Detailing of Beam reinforcement and reactions.

```
=============================================================================
                IS-456    L I M I T    S T A T E    D E S I G N
               B E A M   N O.     435   D E S I G N   R E S U L T S

      M35                      Fe500 (Main)                  Fe500 (Sec.)

    LENGTH:  6000.0 mm      SIZE:   300.0 mm X  600.0 mm   COVER: 35.0 mm


                          DESIGN LOAD SUMMARY (KN MET)
   ----------------------------------------------------------------------------
SECTION |FLEXURE  (Maxm. Sagg./Hogg./Eqv. moments) |          SHEAR
(in mm) |    P        MZ        MX        ME     Load # |   VY        MX        VE   Load #
   ----------------------------------------------------------------------------
    0.0 |    0.00    42.33     6.40     53.63    123 |   46.26    10.29   101.14    100
        |    0.00   -47.44     8.36    -62.20    109 |
  500.0 |    0.00    47.67     6.40     58.97    123 |   41.59    10.29    96.46    100
        |    0.00   -26.52     6.72    -38.38    121 |
 1000.0 |    0.00    50.44     6.40     61.73    123 |   31.78    10.29    86.65    100
        |    0.00   -15.95     4.10    -23.18    133 |
     STAAD SPACE                                               -- PAGE NO.   368

 1500.0 |    0.00    48.28     8.10     62.58    111 |   20.24    10.29    75.11    100
        |    0.00    -3.25     4.10    -10.48    133 |
 2000.0 |    0.00    46.75    10.29     64.91    100 |   19.56     8.36    64.15    109
        |    0.00     0.00     0.00      0.00    100 |
 2500.0 |    0.00    47.71    10.29     65.87    100 |  -16.50     8.10    59.71    111
        |    0.00     0.00     0.00      0.00    100 |
 3000.0 |    0.00    42.56    10.29     60.72    100 |  -16.40    10.29    71.28    100
        |    0.00     0.00     0.00      0.00    100 |
 3500.0 |    0.00    34.81     8.36     49.56    109 |  -28.62    10.29    83.49    100
        |    0.00    -0.28     3.78     -6.94    135 |
 4000.0 |    0.00    27.49     8.36     42.24    109 |  -40.83    10.29    95.70    100
        |    0.00   -12.59     6.40    -23.88    123 |
 4500.0 |    0.00    20.52     6.72     32.39    121 |  -53.05    10.29   107.92    100
        |    0.00   -36.75     6.40    -48.05    123 |
 5000.0 |    0.00    20.08     4.10     27.32    133 |  -64.59    10.29   119.46    100
        |    0.00   -64.81     6.40    -76.11    123 |
 5500.0 |    0.00    14.29     4.10     21.52    133 |  -74.40    10.29   129.27    100
        |    0.00   -95.25     8.10   -109.54    111 |
 6000.0 |    0.00     6.94     4.10     14.17    133 |  -79.07    10.29   133.95    100
        |    0.00  -132.57     8.10   -146.86    111 |
   ----------------------------------------------------------------------------
```

```
                   SUMMARY OF REINF. AREA (Sq.mm)

 ----------------------------------------------------------------------------
 SECTION |         TOP             |        BOTTOM            |    STIRRUPS
 (in mm) | Reqd./Provided reinf.   | Reqd./Provided reinf.    |   (2 legged)
 ----------------------------------------------------------------------------
     0.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
   500.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  1000.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  1500.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  2000.0 |    0.00/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  2500.0 |    0.00/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  3000.0 |    0.00/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  3500.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  4000.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  4500.0 |  285.60/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  5000.0 |  322.02/ 339.29( 3-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  5500.0 |  469.60/ 565.49( 5-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
  6000.0 |  639.27/ 678.58( 6-12d )|  285.60/ 314.16( 4-10d )|  8d  @ 190 mm
 ----------------------------------------------------------------------------


 SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT
 -----------------------------------------------------------------------------

 SHEAR DESIGN RESULTS AT   959.0 mm AWAY FROM END SUPPORT
   VY =    -70.13 MX =     10.29 LD=   100
   Provide 2 Legged   8d  @ 190 mm c/c

 =============================================================================
```

Figure 28Detailing of Beam no 435 in stadd 2

Design of column of structure

The columns are designed to repel the axial loads and the side loads and transfer them effectively to the foundation of the structure. So, as all the loads from shafts, crossbeams are transferred through the columns, it's important to design strong columns. A column may be defined as an element used primary to support axial compressive loads and with a height of a least three times its side dimension. The strength of column depends upon the strength of accoutrements , shape, size of cross section, length and degree of commensurable and dedicational conditions at its ends.

Column Design by STADD PRO

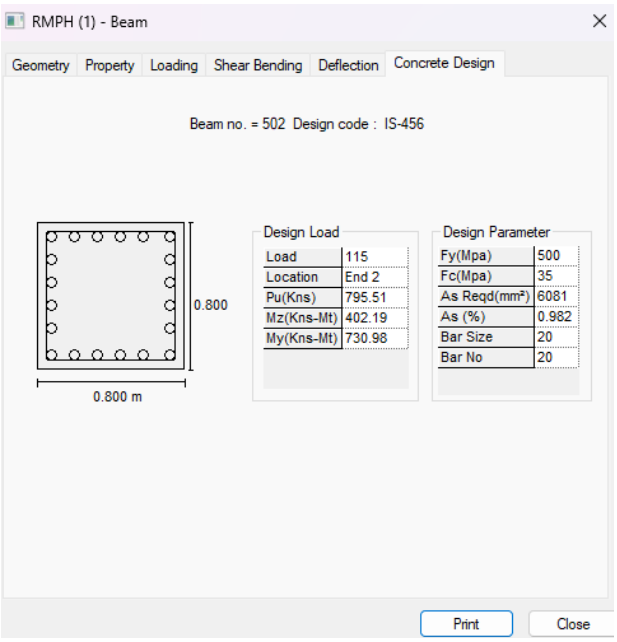


Figure 29 Detailing of column no 502 in stadd

Design parameter about column :-

Column no = 502

Fy = 500(MPA)

Fc = 35 (MPA)

Area of steel requried =6081mm2

Area of steel = 0.982%

Bar size = 20mm

Bar No = 20

Mz =402.19 (Kns - mt)

My = 730.98 (Kns - mt)

Detailing of column reinforcement and reaction

```
           IS-456    L I M I T    S T A T E    D E S I G N
        C O L U M N   N O.    502  D E S I G N   R E S U L T S

      M35                    Fe500 (Main)              Fe500 (Sec.)

  LENGTH:  9000.0 mm   CROSS SECTION:  800.0 mm X  800.0 mm  COVER: 40.0 mm

  ** GUIDING LOAD CASE:  115 END JOINT:   219  SHORT COLUMN


 REQD. STEEL AREA    :     6080.77 Sq.mm.
 INTERACTION RATIO: 1.00 (as per Cl. 39.6, IS456:2000)

 CRITICAL CONDITION : MAXIMUM AREA OF STEEL REQUIRED OF THE 4 CASES.

 REQD. STEEL AREA    :     6080.77 Sq.mm.
 REQD. CONCRETE AREA:   633919.25 Sq.mm.
 MAIN REINFORCEMENT : Provide  20 - 20 dia. (0.98%,   6283.19 Sq.mm.)
                      (Equally distributed)
 TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 300 mm c/c

 SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
 ----------------------------------------------------------
 Puz :  12264.52   Muz1 :   1135.84   Muy1 :   1135.84

 INTERACTION RATIO: 1.00 (as per Cl. 39.6, IS456:2000)

 SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
 ----------------------------------------------------------
 WORST LOAD CASE:   115
 END JOINT:   219 Puz :  12337.23   Muz :   1162.18   Muy :   1162.18   IR: 1.04
```

Figure 30Detailing of column no 502 in stadd

Design of Foundations

Foundation design involves developing a construction blueprint for a structure's foundation. Typically executed by a structural expert, this task is crucial in ensuring the stability of the building. The foundation serves as the structural support system that rests on the ground and bears the weight of the entire structure. It plays a vital role in transferring loads from the building or columns to the earth below. Foundations should be meticulously crafted to prevent excessive settlement or rotation, reduce differential settlement, and provide adequate protection against sliding and overturning.

Design parameter about Footing :-

Unit Weight of Concrete 25.000 kN/m3

Strength of Concrete 25.000 N/mm2

Yield Strength of Steel 500.000 N/mm2

Minimum Bar Size Ø6

Maximum Bar Size Ø32

Minimum Bar Spacing 50.000 mm

Maximum Bar Spacing 500.000 mm

Footing Clear Cover (F, CL) 50.000 mm

Elevation of Isolated footing

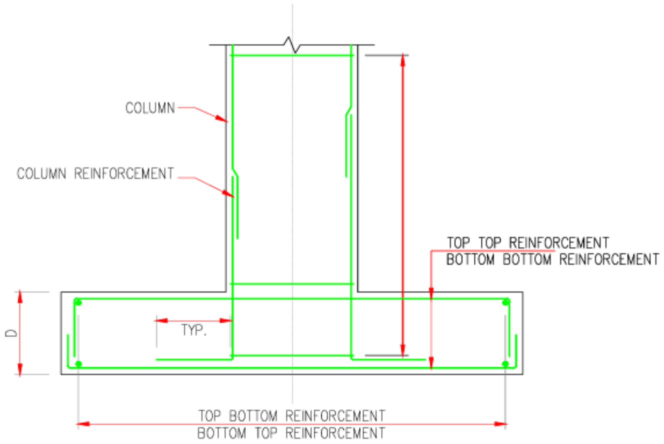


Figure 31 General Footing elevation

Plan of footing

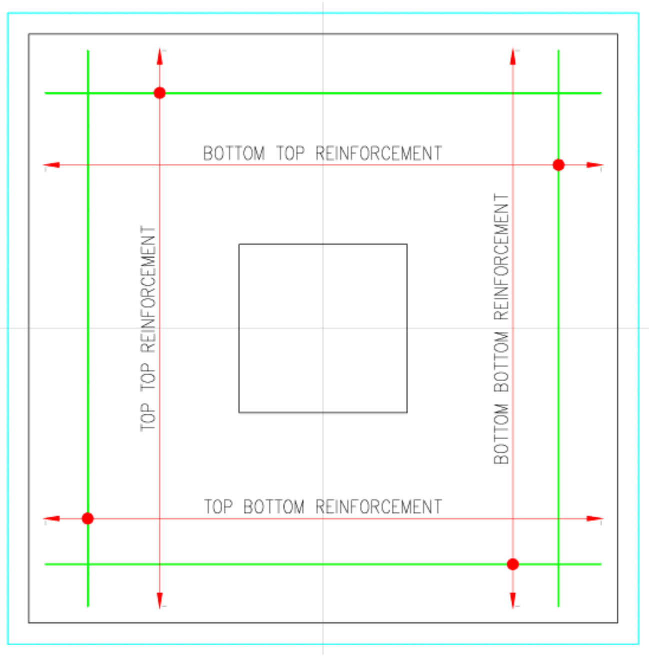


Figure 32 General Footing Plan

Design of reinforcement (For footing at Node 21)

Column size = 800 x 800 mm

Soil Bearing Capacity = 420 KN/M2

Minimum Area of Steel (Ast min) = 810 mm2

Calculated Area of Steel (Ast) = 1059 mm2

Provided Area of Steel (Ast, Provided) = 1256 mm2

Astmin <= Ast Provided Steel area is accepted.

Top steel provided is 16mm at 250mm c/c along both direction

Bottom steel provided is 20mm at 250mm c/c along both direction

Layout of footing

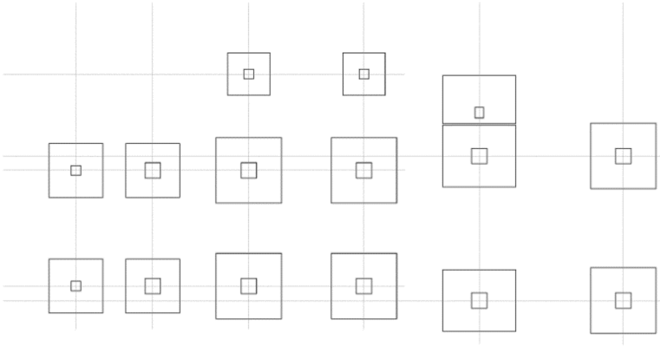


Figure 33 Footing Layout

CONCLUSION

Analysis and designing were done by using software and successfully vindicated manually as per IS456-2000.

Computation by both manually as well as software analysis, gives nearly same result.

Analysis is based on the site conditions of having no seismic governing site but considered for Seismic analysis is based in IS 1893 Part 1.

Maximum nodal displacement in Vertical (Y-direction) is 8.28 cm. Maximum gyration in X, Y, Z- directions are0.017 rad, 0.001 rad, 0.002 rad independently.

Maximum & Minimum Shear Force for beam 510 in Y-direction are 209.06 KN & -331.66 KN.

Maximum & Minimum Axial Force for node 21in X-direction are 699.46 KN & 146 KN.

Quantity of steel provided for building is economical and adequate.

Stadd has the capability to design structures based on site condition and also by combining the types of codes used for designing as per the user demands.

REFRENCES

ASCE -7-05 for Wind load calculation.

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N. Krishna Raju (2005) Advanced reinforced concrete design,2nd edition, as per IS 456:2000, CBS publishers and distributers Pvt. Ltd.

S.S. Bhavikatti (2005), Design of RCC structural elements volume 1, as per IS 456:2000, new age international publisher.