Date: July 27, 2020

DBR-02

CASE STUDY: WAREHOUSE SHED

DESIGN BASIS REPORT

Structural Consultants:
AASHRAY DESIGN CONSULTANTS PVT. LTD.
K-8, 1st Floor, South Ext.-1
New Delhi - 110049
Tel. : 011 46047374, 9310048715
Website: www.adcplindia.com

1.   INTRODUCTION

The proposed Warehouse Shed consists of 186 m long shed having 45 m width with **equal bays and single pitched roof**.

2.   STRUCTURAL SYSTEM

The structure designed with 2 alternative structural configurations:

a. Built-up I sections
b. Tubular sections

And the steel tonnage and indicative costing is compared.

The structures are designed for the expected loads, i.e. Dead Load, Live Load, Wind Load and Seismic Load. Limit State Method of Analysis and Design has been adopted for the design of the shed.

3.   PERIPHERAL WALLS

All peripheral walls have been conceived in Red Bricks with a density of 19.2 KN/m^3. Peripheral walls of height 3 m have been considered on external face of the shed and 0.5 mm thick colour coated cladding above 3 m level.

4.   MODEL GENERATION

The building is planned with the two structural configuration for optimizing the material consumption while meeting structural strength requirements. After preliminary sizing of various structural members, a 3-D CAD Model of the structural frame of the building has been generated using STAAD-Pro Connect Edition software for carrying out computer analysis for the affects of vertical and lateral loads likely to act on the structure. The permissible values of the load factors and stresses has been considered as per guidelines of Indian Standards. The computer analysis has evaluated individual internal forces, reactions at foundation level and deflection pattern of the entire structure and in the individual members. This data has been used to verify adequacy of the member sizes adopted and further iterations have been carried out as required to rationalize the system and sizes of structural members. The whole structure shall be idealized as a space frame.

5.   CONTROL OF DEFLECTION

In order to control deflection of structural elements, the criteria given in IS: 800-2007LSD has been used for all structural members. Detailed deflection calculations have revealed that the sway/deflections of main structural members are within the required limits**.**

6.   RECOMMENDATIONS FOR MINIMIZING COST

(i)   GRID SPACING, MEMBER TYPE AND DIMENSIONS

Grid spacing of 7.75m has been selected with a clear span of 22.5m based on detailed study of the architectural requirements and time and cost optimization.

(ii)   MATERIAL GRADES

For Tubular sections STAAD Model:
Conforming to IS:2062 for rolled steel tube and pipe sections (Fe 355)

For Built-up I sections STAAD Model:
Conforming to IS:2062 for HR plates (Fe 345) and for rolled steel pipe sections (Fe 310)

7.   LOADS & LOAD COMBINATIONS

(i) DEAD LOAD

The dead load on structure includes all the permanent loads attached with structure i.e. self-weight of structure, roofing sheet and solar panels. Following are the permanent loads which have been considered in design & analysis.

- Self Weight of structural members have been considered on the basis of the following criteria.
- Density of Steel   -   78.5 KN/cum
- Weight of connections   -   15 % of self-weight
- Steel rolled sections   -   As per the section tables

- 50 mm th Glass wool + wire mesh   -   3 kg/sq.m. = 0.03 kN/sq.m.
- Roofing Sheet - 0.47 mm thick (TCT) Bare Galvalume Sheet of 550 MPa Grade.
- Weight of sheeting   -   4.5 kg/sq.m. = 0.045 kN/sq.m.
  Load on purlins   -   (.03+0.045)*1.42 = 0.1065 kN/m

- Weight of cladding   -   4.5 kg/sq.m. = 0.045 kN/sq.m
- Side Cladding - 0.5 mm thick (TCT) Colour Coated Sheet of 550 MPa Grade.
  Load on girts   -   0.045*1.42 = 0.0639 kN/m

(ii) IMPOSED LOADS

The following imposed loads as per IS: 875 (Part-2), acting on the structure have been considered:-

- Roof live load - 0.75 kN/sqm = 0.75 x 1.42 = 1.065 kN/m

(iii) WIND LOAD

Wind loads has been estimated considering basic wind speed of 47 m/s, (as per NBC 2016) terrain category 2, 50 years life of structure and as per provisions of IS:875 part 3-2015. Percentage openings in between 5 to 20% of wall area.

S. No.	Input Factors	Symbols	Value	Depending Factor		Units			Area	Ka	
1	Basic wind speed	Vb	47.00			m/s		Clause	10	1	
2	Probability Factor	k1	1.00						25	0.9	
3	Terrain roughness	k2	1.00	Terrain Category 2				6.3.1	100	0.8	
4	Topography factor	k3	1.00					6.3.2			
5	Importance factor	k4	0.90					6.3.3	Slope	1	12
6	Design wind speed	Vz	42.30			m/s		6.3.4	Roof angle	4.763642	rad
7	Wind Pressure	Pz	1.07			KN/m^2			L	186	m
8	Wind Directionality	Kd	0.90						W	45	m
9	Combination factor	Kc	0.90						H	9.6	m
10	Coeff. Of internal pressure	Cpi	0.50	-0.50 5%<Percentage Openings <20 %					H/W	0.21	
11	Directions	+ve	Towards shed						L/W	4.13	
		-ve	Away from shed						Design Wind Load (KN/m)		
12	Area averaging								0		90
			Tributary width	Tributary length	Tributary Area	Ka	Pd>.7*Pz		0.50	-0.50		0.50	-0.50
									WLL+	WLL-		WLONG+	WLONG-
a)	Purlins											
	EF/EG		1.42	7.75	11.01	0.99	0.86	-0.90	-1.72	-0.49	-0.80	-1.59	-0.37
	GH/FH		1.42	7.75	11.01	0.99	0.86	-0.40	-1.10	0.12	-0.40	-1.10	0.12
b)	Side Wall Girts											
	A		1.42	7.75	11.01	0.99	0.86	0.70	0.25	1.47	-0.50	-1.23	0.00
	B		1.42	7.75	11.01	0.99	0.86	-0.25	-0.92	0.31	-0.50	-1.23	0.00
c)	End Wall Girts											
	C		1.42	7.5	10.65	1.00	0.87	-0.60	-1.35	-0.12	0.70	0.25	1.48
	D		1.42	7.5	10.65	1.00	0.87	-0.60	-1.35	-0.12	-0.10	-0.74	0.49

(iv) EARTHQUAKE LOAD

In light weight low-rise structures such as the proposed building, seismic loads are inconsequential while wind load affects are pre-dominant, still seismic loads have been evaluated by static method and the structure have been checked for adequacy for relevant seismic load combinations.

Seismic Co-efficient Method has been adopted as per IS:1893 (Part-1): 2016with the following data.

Ah   = $(Z * Sa) / (2 * (R/I) * g)$

     Ah   is Design horizontal seismic coefficient.

Z   is Zone factor = 0.24   (Structure lies in Zone IV).

I   is Importance factor = 1.0

T   is   Time period as per clause 7.6.2 b) of IS:1893

     R   is Response reduction factor = 4 for Ordinary Moment Resisting Frames

     (Sa/g) is average response acceleration coefficient. This is the function of the fundamental time period of vibration of the structure and the type of the founding soil, the value shall be considered for Soil Type III, as per Geotechnical report and 7.6.2 (b) of IS:1893, 2016.

(v)   <u>LOAD COMBINATIONS</u>:

D – Dead Load
L - Live Load
W - Wind Load
E - Combined effect of Seismic induced forces

IS-800-2007 – ULS:
Basic Load Combinations

1) 1.5 D + 1.5 L
2) 1.2 D + 1.2 L + 1.2 W
3) 0.9 D + 1.5 W
4) 1.5 D + 1.5 W

Seismic Load Combinations
5) 1.2 D + 1.2 L + 1.2 E
6) 0.9 D + 1.5 E
7) 1.5 D + 1.5 E

Note:-
1) ULS - Denotes Ultimate Limit State (For Strength Design)
2) Live roof and floor is treated as one class of imposed loads
3) Collateral Load is considered in Dead Load

IS-800-2007 – SLS:
Basic Load Combinations
1) D + L
2) D + 0.8 L + 0.8 W
3) D + W

Seismic Load Combinations
4) D + 0.8 L + 0.8 E
5) D + E

Note:-
1) SLS - Denotes Serviceability Limit State (For Deflection)
2) Live roof and floor is treated as one class of imposed loads
3) Collateral Load is considered in Dead Load
4) The combination is only reported for reference, it cannot be used, since the limits are not provided for these combinations.

DESIGN STANDARDS

The important codes which are being followed are.

a)   IS:800 - 2007 , General Construction in Steel, Code of Practice

b)   IS: 875 (Part-I, II), Code of practice for Design loads (other than earthquake)

c)   IS: 875 (Part-III) – 2015, Code of practice for Design Loads (Wind Load)

d)   IS: 1893 part 1-2016 (Criteria for E/Q Resistant Design for Structure)