Design And Analysis of Car Workshop

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Abstract

This paper discusses the structural analysis of a car workshop using STAADPro. The analysis included evaluating the bracing, tapered columns, beam, tension members, and joints of the structure. Special attention was paid to the critical parts of the building that were subjected to high loading conditions. The proposed structure was designed according to IS 800:2007, and the analysis of dead, live, and wind loads was carried out following IS 875:1987 (Part-I, Part-II, Part-III) standards. The building was exposed to three major loads, which were collateral load, wind load, live load, and self-weight i.e., dead load. The primary aim of the analysis was to optimize the steel usage in the structure for safe and economical construction. Some parts of the structure were redesigned to reduce weight, which was achieved through optimization of steel. The cross-section properties, particularly the tapered beam and column, were altered, affecting the overall economy and safety of the structure. The design and analysis incorporated practical knowledge, which is crucial in any project. The study also evaluated the cost variation and estimated the RCC and Steel workshop and the 3D model developed using AutoCAD software.

Keywords: STAAD Pro, Car Workshop, Structural Steel Design, Frame Design, Foundation Design, Three-Dimensional Modeling.

1. Introduction

In today's era, technology has significantly impacted architecture and has evolved from short stone and wood structures to steel structures. Structural steel has emerged as the most reliable building material, and as a result, many buildings and infrastructure are constructed using it. The development of structural steel as a building material has greatly influenced the current growth in industrialization due to its strength, durability, and ease of construction. Steel structures are utilized in various modern constructions, including massive industrial buildings. Car workshops are usually made of steel structures and can serve multiple purposes. IS 800:2007 is the regulation introduced for designing steel structures.

1. Objective

(A) This paper proposes to undertake a structural analysis of a car workshop using STAADPro software.

• The primary objectives of this analysis are to identify the various loads and load combinations acting on the structure.

•And to design the workshop in a manner that ensures safety and cost-effective construction.

(B)Another aspect of the research will focus on the cost and estimation comparison between RCC and Steel car workshops.

(C) Lastly, generate a 3D model of the workshop using AutoCAD software.

2. General

Industrial buildings typically consist of bays with frames that span in the width direction. Several frames are arranged at appropriate spacing to achieve the necessary length, and multiple bays may be constructed together as per the requirements.

The inclusion of bracings in these structures effectively minimizes differential deflection between frames caused by crane surges seen in industrial buildings. These braces also offer lateral support to small and tall building columns, enhancing the column's buckling strength. For Pre- Engineered Building (PEB) design, stability is provided in both the lateral and longitudinal directions. In the lateral direction, a Moment Resisting Frame is utilized, while a Braced Frame is employed in the longitudinal direction.

3. Loads and load combinations

•Dead load: This load includes the weight of the structure itself, like the roofing, purlins, bracings, G.I. sheets, and other accessories.

•As per the Indian Standard Code IS: 875 (Part 2) - 1987, the live load for roofs without access is 0.75 kN/m^2. However, for every degree of roof slope above 10 degrees, there is
a reduction of 0.02 kN/m2 to be considered.

•Wind load: According to IS: 875 (Part 3) - 1987, wind load is calculated based on the basic wind speed for the location of the building, usually measured in m/s with a rating of 47m/s.

•Load combinations: To decide load combinations and to design members accordingly, the following codes are used:

1. IS 875-1987 for load calculation
2. IS 800:2007 for load calculation

2. Literature review

Numerous research papers analyzing the effectiveness of steel structures have been published by researchers.

One such study was conducted by A.D. Bhosale, Archit Pradip Hatkhambar, and Rupesh Vinayak Katkar in 2018, where they analyzed and designed a multi-storey building utilizing STAAD Pro V8i. Their analysis showed that STAAD Pro offered high accuracy and significant time savings in design. Dead load, live load, combination, and wind loads were all factored into the designing process.

In another study, Nauman Khurram et al. in 2018 examined the relationship between unbraced length ratio and flange local slenderness ratio in “Optimization of Flange and Web Slenderness for Pre-Engineered Steel Sections”. The study revealed that while compact flanges were not always the most economical solution and strength could be reduced, a web slenderness ratio of 160 and above yielded good results for members with high bending effects.

Dinesh Kumar Gupta and Mirza Aamir Baig (2017) performed an analysis to compare the Limit State Method (LSM) and Working Stress Method (WSM) for designing an industrial steel storage shed using STAAD Pro software. They concluded that the area of the section designed using LSM was approximately 12% less than that designed using WSM. Hence, they recommended using the LSM for structural design as it is more reliable and cost-effective than the WSM.

In another study, Paolo Cicconi et al. (2016) proposed a design methodology for optimizing the weight of steel structures used in oil and gas power plant modules. By using a Finite Element Method (FEM) analysis methodology that involves varying several parameters to generate various steel section profiles and building systems, they achieved a mass reduction of 5-15%. A database of section profile groups that are suitable for buildings of various spans and dimensions was formulated.

3. Methodology

In the present study, the area and size of the proposed structure were determined based on the specifications of the Mahindra Car Workshop.

TABLE 1: DETAILS OF THE CAR WAREHOUSE:

Sr. No.	Particulars	Description
1	Type Of Building	Steel Building
2	Type Of Structure	Single – Storey Car Workshop
3	Length	45m (c/c)
4	Width	18m (c/c)
5	Clear Height	7.0m
6	Brick Wall	3.0
7	Basic Wind Speed	47m/s
8	Roof Slope	1:10
9	Solar Panel Load	25 kg/sqm on roof

4 - ANALYSIS OF STRUCTURE

4.1 Modelling of structure

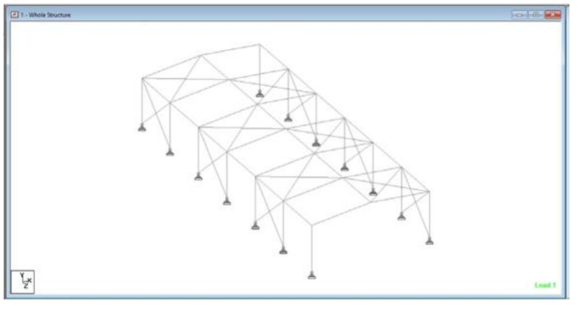


Fig 1 shows the geometry of the structure

The design and analysis of a car workshop with a length of 18m, consisting of a tapered frame with a bay spacing of 7.5m, a span of 45m, and clear height of 7m with a roof slope of 1:10. The calculation of the dead load includes the self-weight of the structure, purlins, roof sheet, bracing, and other accessories. For nodal dead loads, the wind load was calculated according to IS 875 (Part 3)-1987 by considering a basic wind speed of 47m/s in Delhi. The calculation of wind load (F) on the roof truss was carried out by the static wind method using the formula

$$F=(Cpi-Cpe) * A * Pd$$

while wind pressure was calculated and tabulated. The critical wind pressure/loads were used for designing. Load combinations were adopted as (DL1.5) + (LL1.5) and (DL1.5) + (WL1.5), as per Clause 3.5.1 and 5.3.3 They have utilized ISMB200 for the tapered beam in the structure, while the columns are designed as a compression member which carries the roof structure loads.

4.2 Assigning of Loads

- Dead Load
- Live Load
- Wind Load
- Collateral Load

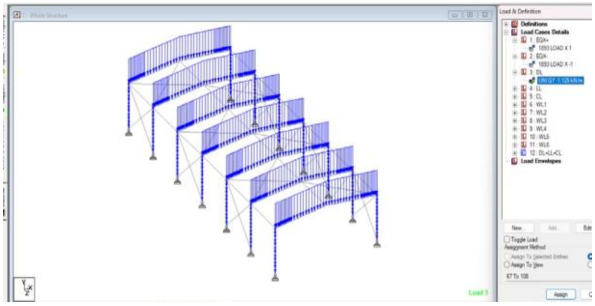


Fig. 2 computed self weight assigned

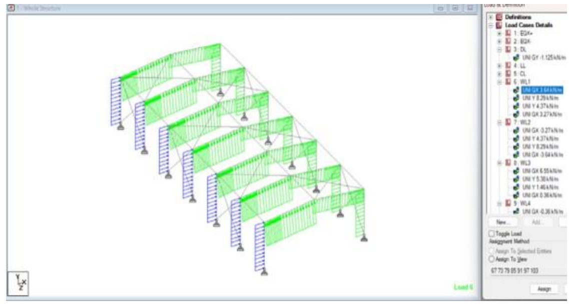


Fig. 4 computed wind load assigned

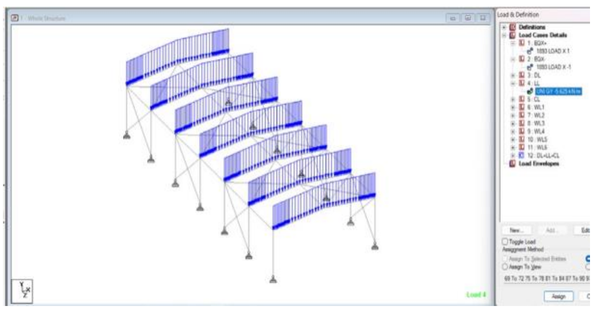


Fig. 3 computed Live Load assigned

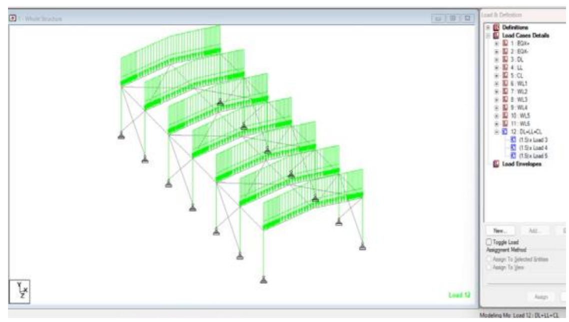


Fig. 5 computed collateral load assigned

5 – Properties assigned to the whole structure.

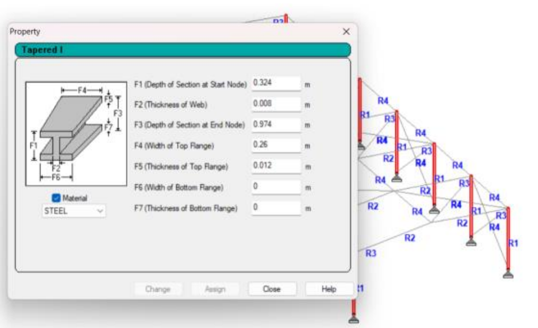


Fig 1

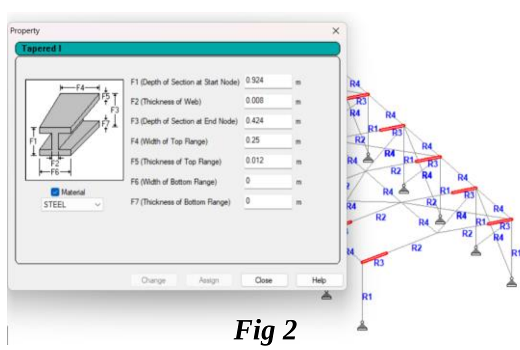


Fig 2

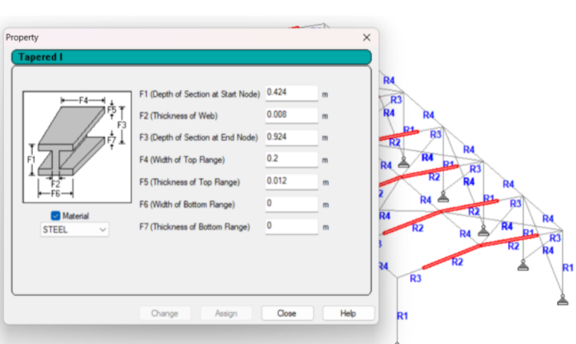


Fig 3

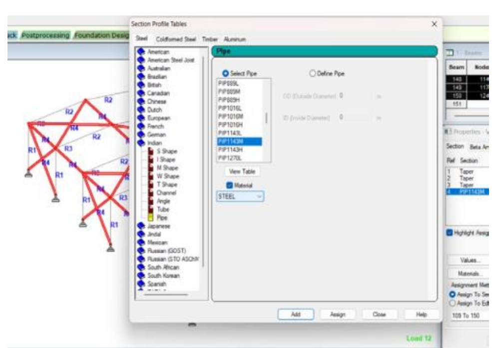


Fig 4

6 - STAAD PRO RESULTS

The analysis done from considering all the above parameters state that the structure is safe without any errors

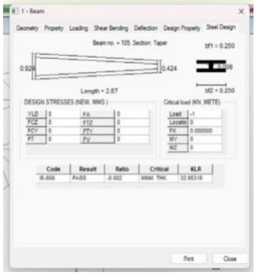


Fig 2 showing steel design of the element

6.1 - Bending Moments Output

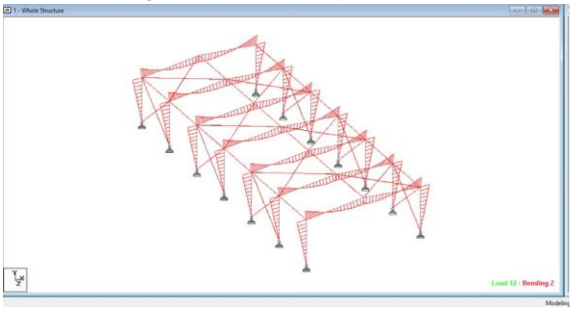


Fig 3 showing bending moment diagram of the structure

6.2 - Shear Forces Output

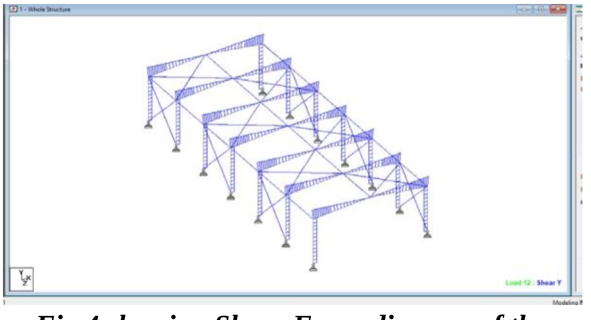


Fig 4 showing Shear Force diagram of the structure

6.3 - Displacements Outputs

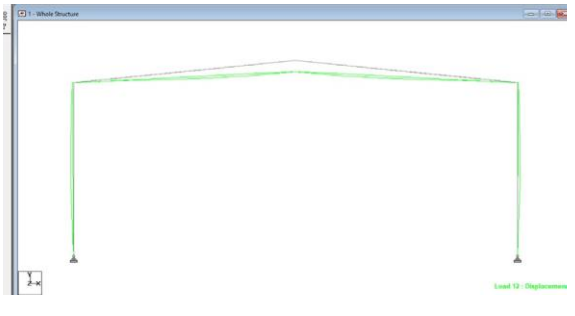


Fig 5 showing Displacements of the structure

7 - Wind Load Calculations

WIND LOAD CALCULATION SHEET

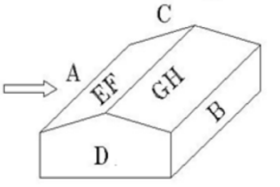
LENGTH (L)	=	45	m	Basic Wind speed,Vb=	47	m/s	
WIDTH(W)	=	18	m	Terrian Category =	2		
HEIGHT(H)	=	7.5	m	Bay Spacing(sidewall) =	7.5	End =	6.0
SLOPE =	1	10		Enclosed Condition	0.2	-0.2	

Calculation for wind pressure :

k1 =	1.00	General building, As per Table-1 of IS-875-Part-3			
k2 =	1.000	For Terrian category 2 as per Table 2, Clause: 6.3.2.1-b			
k3 =	1.00	Upwind slope is less than 3 degree			
k4 =	1.00	for Non Cyclonic Region			
Vz =	k1xk2xK3xK4XVb =		47 m/s		
wind pressure Pz = 0.6Vz^2 =			1325.4 N/m2 =	1.33	kN/m2
Kd =	0.9	(Directionality factor)			
Ka =	0.9	(Area Averaging factor)			
Kc =	0.9	(Combination factor for pressure & Suction)			
Design wind pressure Pd(not be taken less than 0.7Pz) KdxKaxKcxPz =				0.97	kN/m2

H/W = 0.42 → h/w≤0.5

L/W = 2.50 → 1.5<l/w≤4



Wind load on frame

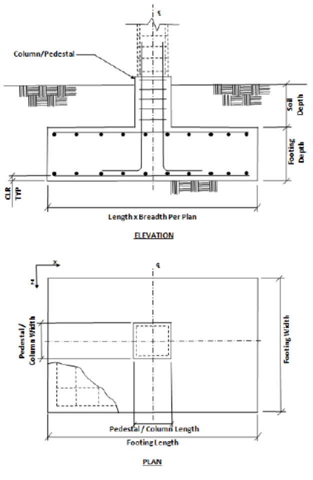
SURFACE	Cpe	Cpi	Cp=(Cpe-Cpi)	Wind load on frame	
CASE-1- WIND ACROSS THE RIDGE(ZERO DEGREE) Positive Cpi					
A	0.70	0.2	0.50	0.5x0.97x7.5=	3.64
EF	-0.94	0.2	-1.14	-1.14x0.97x7.5=	-8.29
GH	-0.40	0.2	-0.60	-0.6x0.97x7.5=	-4.37
B	-0.25	0.2	-0.45	-0.45x0.97x7.5=	-3.27
C	-0.60	0.2	-0.80	-0.8x0.97x6=	-4.66
D	-0.60	0.2	-0.80	-0.8x0.97x6=	-4.66
CASE-2- WIND ACROSS THE RIDGE(ZERO DEGREE) Negative Cpi					
SURFACE	Cpe	Cpi	Cpe-Cpi	Wind load on frame	
A	0.70	-0.2	0.9	0.9x0.97x7.5=	6.55
EF	-0.94	-0.2	-0.74	-0.74x0.97x7.5=	-5.38
GH	-0.40	-0.2	-0.2	-0.2x0.97x7.5=	-1.46
B	-0.25	-0.2	-0.05	-0.05x0.97x7.5=	-0.36
C	-0.60	-0.2	-0.4	-0.4x0.97x6=	-2.33
D	-0.60	-0.2	-0.4	-0.4x0.97x6=	-2.33
CASE-3- WIND PARALLEL TO RIDGE(90 DEGREE) WITH Posative Cpi					
SURFACE	Cpe	Cpi	Cpe-Cpi	Wind load on frame	
A	-0.50	0.2	-0.7	-0.7x0.97x7.5=	-5.09
EG	-0.80	0.2	-1	-1x0.97x7.5=	-7.28
EG	-0.80	0.2	-1	-1x0.97x7.5=	-7.28
B	-0.50	0.2	-0.7	-0.7x0.97x7.5=	-5.09
C	0.70	0.2	0.5	0.5x0.97x6=	2.91
D	-0.10	0.2	-0.3	-0.3x0.97x6=	-1.75
CASE-4- WIND PARALLEL TO RIDGE(90 DEGREE) WITH Negative Cpi					
SURFACE	Cpe	Cpi	Cpe-Cpi	Wind load on frame	
A	-0.50	-0.2	-0.3	-0.3x0.97x7.5=	-2.18
EG	-0.80	-0.2	-0.6	-0.6x0.97x7.5=	-4.37
EG	-0.80	-0.2	-0.6	-0.6x0.97x7.5=	-4.37
B	-0.50	-0.2	-0.3	-0.3x0.97x7.5=	-2.18
C	0.70	-0.2	0.9	0.9x0.97x6=	5.24
D	-0.10	-0.2	0.1	0.1x0.97x6=	0.58

8 – Isolated Foundation Design

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
78	1	5.200 m	5.200 m	0.305 m
80	2	6.500 m	6.500 m	0.305 m
85	3	5.200 m	5.200 m	0.305 m
87	4	6.500 m	6.500 m	0.305 m
92	5	5.200 m	5.200 m	0.305 m
94	6	6.500 m	6.500 m	0.305 m
99	7	5.200 m	5.200 m	0.305 m
101	8	6.500 m	6.500 m	0.305 m
106	9	5.200 m	5.200 m	0.305 m
108	10	6.500 m	6.500 m	0.305 m
113	11	5.200 m	5.200 m	0.305 m
115	12	6.500 m	6.500 m	0.305 m
120	13	5.200 m	5.200 m	0.305 m
122	14	6.500 m	6.500 m	0.305 m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
78	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
80	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A
85	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
87	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A
92	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
94	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A
99	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
101	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A
106	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
108	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A
113	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
115	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A
120	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
122	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 55 mm c/c	Ø6 @ 65 mm c/c	N/A	N/A

Isolated Footing 78



Input Values

Footing Geomtery

Design Type : Calculate Dimension
ooting Thickness (Ft) : 305.000 mm
oting Length - X (Fl) : 1000.000 mm
oting Width - Z (Fw) : 1000.000 mm
tricity along X (Oxd) : 0.000 mm
tricity along Z (Ozd) : 0.000 mm

Column Dimensions

Column Shape : Rectangular
lumn Length - X (Pl) : 0.649 m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STEEL TAKE-OFF
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  PROFILE                       LENGTH(METE)     WEIGHT(KN  )

Tapered   MembNo:       1          32.09            32.540
                                            ----------------
                                   TOTAL =          32.540

MEMBER       PROFILE                  LENGTH         WEIGHT
                                      (METE)         (KN  )

   1          TAP ERED                 7.00           7.098
   2          TAP ERED                 7.00           7.098
   3          TAP ERED                 9.04           9.172
   4          TAP ERED                 9.04           9.172
                                          ----------------
                                   TOTAL =           32.540

************ END OF DATA FROM INTERNAL STORAGE ************

220. FINISH
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Earlier the weight of the one frame was 32.54 KN or 3254 KG

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STEEL TAKE-OFF
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  PROFILE                       LENGTH(METE)     WEIGHT(KN  )

Tapered   MembNo:       1          14.00            12.088
Tapered   MembNo:       3           5.74             4.939
Tapered   MembNo:       5          12.35             9.487
                                            ----------------
                                   TOTAL =          26.514

MEMBER       PROFILE                  LENGTH         WEIGHT
                                      (METE)         (KN  )

   1          TAP ERED                 7.00           6.044
   2          TAP ERED                 7.00           6.044
   3          TAP ERED                 2.87           2.469
   4          TAP ERED                 2.87           2.469
   5          TAP ERED                 6.17           4.744
   6          TAP ERED                 6.17           4.743
                                          ----------------
                                   TOTAL =           26.514

************ END OF DATA FROM INTERNAL STORAGE ************
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Optimized final weight of the one frame is 26.514 KN or 2651 KG.

9 - RESULTS

The structural members were designed in compliance with IS code specifications, accounting for the loads on the structure. Through optimization, the weight of one frame was reduced from 32.54 KN or 3254 KG to 26.514 KN or 2651 KG.

10 – Cost and Estimation variability between Rcc and Steel Structures

10.1 – Estimation of Rcc Car Workshop

Total cost for Rcc Works – Rs. 2510232
Total cost for Labour charges – Rs. 2556961
Overall cost – Rs. 5067193

10.2 – Estimation of Steel Car Workshop

Total cost for Steel Works – Rs. 6079821
Total cost for Labour charges – Rs. 2004883
Overall cost – Rs. 8084704

RCC Building

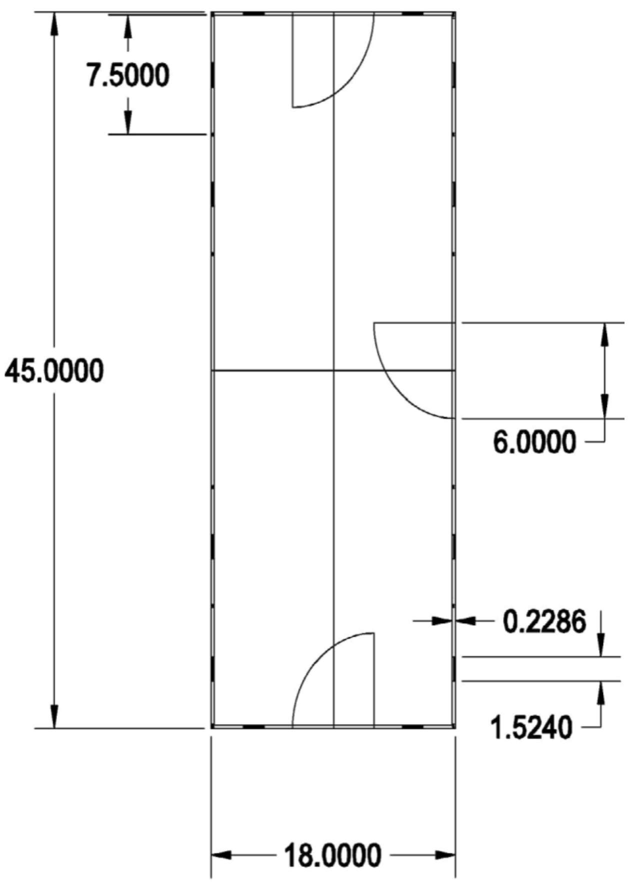
S no.	Item disciption	No.	L(ft)	B (ft)	H (ft)	Quantity (cuft)	Rate (Rs)	Cost (Rs)
1	Excavation for foundation	21	6	6	5	3780		
2	Pcc at foundation	21	5	5	0.25	131.25		
	cement (bag)					35	325	11375
	sand (cuft)					63	50	3150
	aggregate (cuft)					126	68	8568
3	Footing rectangular portion	21	4	4	0.75	252		
	cement (bag)					65	325	21125
	sand (cuft)					120.96	50	6048
	aggregate (cuft)					241.92	68	16450.56
	steel (kg)					35	70	2450
4	Column concrete upto plinth level	21	1	1	5	105		
	cement (bag)					25	325	8125
	sand (cuft)					46.32	50	2316
	aggregate (cuft)					92.88	68	6315.84
	steel (kg)							
	main					68.55	65	4455.75
	link (stirrups)					111.41	48	5347.68
5	Brick work upto plinth level					5832	5	29160
6	Earth filling	1	59.05	147.6		8715.78		
	8715.78-3780=4935							
	excavation charges					4935	10	49350
	transportation charges					4935	4.17	20578.95
	labour charges					4935	3	14805
7	Floor tiles	1	59.05	147.6		8715.78	51	444504.78
8	Plinth beam							
	cement (bag)					70	325	22750
	sand (cuft)					120	50	6000
	aggregate (cuft)					240	68	16320
	steel (kg)					872.1	60	52326
9	Lintle beam							
	long wall	2	147.6	1	0.75	221.4		
	short wall	7	59.05	1	0.75	310.0125		
					total	531.41		
	cement (bag)					90	325	29250
	sand (cuft)					134	50	6700
	aggregate (cuft)					255	68	17340
	steel (kg)					892.3	60	53538
10	Column concrete for super structure	21	1	1	14.58	306.18		
11	Brick work in super structure							
	long wall	2	147.6	1	14.58	4304.016		
	short wall	2	59.05	1	14.58	1721.898		
					total	6025.914		
	Deduction							
	door	3	10	1	10	300		
	windows	8	5	1	2	80		
					total	380		
	Deduction due to lintle concrete					531.41		
	Deduction for column	14	1	1	14.58	204.12		
	Actual brick work =							
	6025.914-380-531.41-204.12=4910 cuft					66285	6	397710
	13.5 brick in 1 cuft							
12	Material for column	21	1	1	19.58	411.18		
	cement (bag)					107	325	34775
	sand (cuft)					197.28	50	9864
	aggregate (cuft)					394.56	68	26830.08
	steel (kg)							
	main					234.65	65	15252.25
	link (stirrups)					371.28	48	17821.44
13	Slab concrete	1	147.6	59.05	0.41	3573.4698		
	cement (bag)					535	325	173875
	sand (cuft)					1008	50	50400
	aggregate (cuft)					2018	68	137224
	steel (kg)					7062.66	65	459072.9
14	Plastering work							
	horigontal wall	2	59.05		14.58	1721.898		
	vertical wall	2	147.6		14.58	4304.016		
					total	6025.914		
	Deduction							
	doors	1.5	10		10	150		
	windows	4	5		2	40		
					total	190		
	total plastering work							
	6025.914-190=5835.914sqft							
	cement (bag)					66	325	21450
	sand (cuft)					323.7	50	16185
15	Form work							
	column	21				739	17	12563
	beam					1356	14	18984
	slab					3573.4698	30	107204.094
16	Mortar for brick work					157.98		
	cement (bag)					208	325	67600
	sand (cuft)					1701.44	50	85072
							TOTAL	2510232
Column1	Labour charges for :-							
1	excation for foundation					3780	10	37800
2	pcc at foundation					131.25	30	3937.5
3	footing rectangular portion					252	30	7560
4	column concrete upto plinth level					105	30	3150
4	brick work up to plith level					832	25	20800
5	earth filling					8715.78	8	69726.24
6	floor tiles					8598	50	429900
7	plinth beam					531.41	30	15942.3
8	lintle beam					531.41	30	15942.3
9	brick work in super structure					5575	25	139375
10	column					411.18	30	12335.4
11	slab concrete					3575.4698	150	536320.47
12	plastering work					5835.914	15	87538.71
13	Plumbing,Electric and Wood					8715.8	120	1045896
14	Architect					8715.8	15	130737
							TOTAL	2556961
						OVERALL COST		5067193

STEEL STRUCTURE

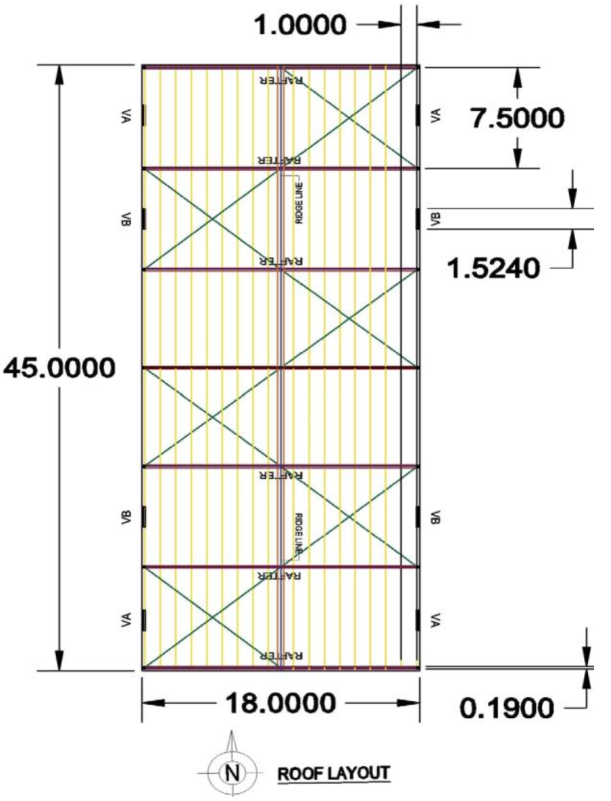
S no.	Item disciption	No.	L(ft)	B (ft)	H (ft)	Quantity (cuft)	Rate (Rs)	Cost (Rs)
1	Excavation for foundation	14	6	6	5	2520		
2	Pcc at foundation	14	5	5	0.25	87.5		
	cement (bag)					18	325	5850
	sand (cuft)					32	50	1600
	aggregate (cuft)					63	68	4284
3	Footing rectangular portion	14	4	4	0.75	168		
	cement (bag)					32	325	10400
	sand (cuft)					60.5	50	3025
	aggregate (cuft)					120.3	68	8180.4
	steel (kg)					19	70	1330
4	Column concrete upto plinth level	14	1	1	5	70		
	cement (bag)					13	325	4225
	sand (cuft)					23	50	1150
	aggregate (cuft)					45.5	68	3094
	steel (kg)							
	main					35	65	2275
	link (stirrups)					55.5	48	2664
5	Brick work upto plinth level (bricks)					2916	6	17496
6	Earth filling	1	59.05	147.6		8715.78		
					8715.78-2520=6195.78			
	excavation charges					6195.78	10	61957.8
	transportation charges					6195.78	4.17	25836.403
	labour charges					6195.78	8	49566.24
7	Floor tiles (no. of tiles)	1	59.1	147.6		8723.16	51	444881.16
8	Plinth beam							
	cement (bag)					35	325	11375
	sand (cuft)					60	50	3000
	aggregate (cuft)					120	68	8160
	steel (kg)					436	60	26160
9	Anchor bolt	112				112	50	5600
10	Tapered column (tonn)	14				26.698	65000	1735370
11	Rafter (tonn)	14				30.768	75000	2307600
	no. of bolts to joint rafter and column					112	50	5600
	no. of bolts to joint rafter to rafter					28	50	1400
12	Purline	108				6000	75	450000
	fastener					120	15	1800
13	Girts	168				7000	75	525000
	fatener					180	15	2700
14	Braces	48				48	450	21600
15	Colour coated roof monitor	1010					150	151500
16	Roof insulator					3940	15	59100
17	Wall sheet					3420	33.93	116040.6
							TOTAL	6079821
	Labour charges for :-							
1	excation for foundation					2520	10	25200
2	pcc at foundation					87.5	30	2625
3	footing rectangular portion					168	30	5040
4	column concrete upto plinth level					70	30	2100
4	brick work up to plith level					2060	25	51500
5	earth filling					8715.78	8	69726.24
6	floor tiles					8715.78	50	435789
7	plith beam					309	30	9270
8	rafter and colum							40000
9	purline							90000
10	colour coated roof monitor							44000
11	wall sheet							53000
12	Plumbing,Electric and Wood					8715.8	120	1045896
13	Architect					8715.8	15	130737
							TOTAL	2004883
						OVERALL COST		8084704

11 – Building 3D Model using AutoCAD Software

11.1 – 2D Layout and Views

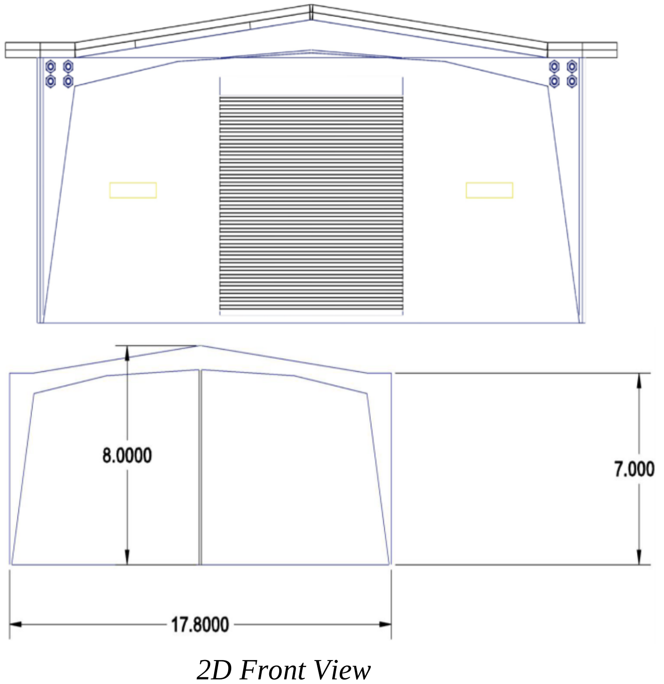


2D Layout



2D Top View

MAHINDRA CAR WORKSHOP



2D Front View

3D View of Workshop (Inside)

12 – Conclusion

1) The initial cost of steel structure is costly then RCC, but the resale value of steel is more then RCC.

2) Steel structure takes less time with respect to RCC but it required skilled Labour.

3) By using STAAD pro, we get the optimum value and quantity of material by which the cost of structure get minimum then the actual cost of structure.

4) Using foundation design, isolated footing is more economical and durable footing for workshop.

13. References

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2. Book

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2. *Dr. B.C. Punmia, Dr. Ashok Kumar Jain, Dr. Arun Kumar Jain, The book of" Design of steel structures", Second edition, Lakshmi Publications(P)Ltd,113, Golden house Darya Ganj, New Delhi, March **2009.***