



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 6, June 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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www.ijirset.com

Design and Drafting of Agricultural Structures

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ABSTRACT: The study helps the developers and farmers by providing technical data for the construction of agricultural structures. The proper orientation of the greenhouse structure is important to avail an adequate amount of sunlight to the plants. Also, the climatic factors inside the greenhouse must be appropriate according to the crop. The ventilation must be sufficient to maintain the temperature inside the greenhouse. The polyhouse structure and dairy barn structure are designed to withstand wind speeds of 44m/s (158.4 km/h). A dairy barn helps the animal to rest comfortably. Dimensions for the dairy barn structure were found to be as length 40m, width 13m, eaves height 2.5m, central height 4.5m, angle of roof 30°

I. INTRODUCTION

In the present scenario, the demand for an exponentially growing population has to be met from limited available resources which exerts continuous pressure on agricultural land and agriculture. So that it is important to introduce controlled cultivation technology in agriculture.

The climatic conditions in the Konkan region are hot and humid. The rainfall is too heavy (4000 mm) so cultivation in an open field other than paddy is not possible, therefore there is a need for a polyhouse in the Konkan region for the cultivation of different crops. Also, the land holding capacity of farmers is less, hence small size polyhouse of 200 m² has been adopted by the farmers. Regarding the climatic condition and topography of the region, the even span type polyhouse was considered. For better yield from dairy animals in the Konkan region, the dairy barn must have to be designed, to assist farmers and other decision-makers in the design of dairy cattle housing. The present design was done for 72 animals in a dairy barn.

Paper is organized as follows. Section II describes the review materials used for the project. The steps in designing of the agricultural structures are given in Section III. Section IV presents experimental results showing results of calculations done for finding the dimensions of the designed structures and the conclusions are shown in Section V. Finally, Section VI presents references used in this project.

II. RELATED WORK

Chandra (1992) studied the parameters mostly suitable in Indian agro-climatic conditions for greenhouse design. More sunlight is available in the winter season in north-south oriented greenhouses compared to east-west oriented greenhouses. Sargar and Dhage (2015) designed galvanized iron naturally ventilated polyhouse suitable for the Konkan region. The polyhouse was designed for a 100 m² floor area by using NGMA standards and various IS codes. IS code 875 is used for the estimation of loads acting on the structure. Fernandez *et al.* (2006) studied and developed algorithms to assist farmers and developers in designing of cattle housing. DeVries *et al.* (2004) studied the effect of feeding space on inter-cow distance, aggression.

Anonymous (1968) deals with the use of steel tubes in general building construction. Anonymous (1970) deals with stall dimensions, ventilation, milking parlour, manure management, and flooring for farm cattle housing for large dairy farms. Anonymous (1986) covers recommendations for cattle housing for an average farmer. This standard recommends a layout and constructional details of a cattle shed meant for an average farmer normally having three milch animals with their calves and a pair of bullocks. Anonymous (1987) deals with dead load to be assumed in the

design of a building and the same is given in the form of unit weight of materials. Anonymous (1991) covers the construction of brick masonry in general and the erection of brick walls in particular. Anonymous (1998) deals with the specifications of steel tubes for structural purposes. Anonymous (2007) deals with general construction using hotrolled steel sections joined using riveting bolting and welding.

III. METHODOLOGY

Design of Galvanized Iron Naturally Ventilated Polyhouse of 200 sq.m floor area

According to the procedure laid down in Indian standard codes for structural design, G.I. pipes, comfort of dairy cattle, construction of buildings the polyhouses of specific requirements and dairy barn structure were designed and drafted.

Design of dairy barn agricultural structural for 72 animals Selection of the site

Site shall be located in dry, elevated, and well-drained areas where there is sufficient scope for future expansion. There should be adequate water supply available at a low cost. The site shall be located away from public roads, but be easily accessible throughout the year. The site shall be selected in such a way that the cattle sheds are oriented in an east-west direction

Deciding herd size

The herd of 72 animals, approximately consists of about 20 milking animals, 10 dry animals, 25 heifers, 2 young males, 1 bull, 1 bullock, and remaining calves.

These material estimates may vary with different herds of the same sizes.

Layout of the different elements of the dairy barn

The layout of the structure mainly consists of a cattle section, storage section maintenance section, and space for future expansion. The cattle section consists of a milking animal shed, suckling calves shed, dry animal shade, down calver shade, young stock shed, calf shed, bull shade, and service crate. The storage section includes the ration room, concentrate godown, fodder godown, chaffing shed, and silos. The maintenance section includes the implement and workshop shed and compost pits for manure disposal.

Allocation of enough space for each animal

The dimensions of the standing are decided according to the average size of the animal for free movement of an animal. According to it, the average length of standing is ranging from 1.5 m to 1.7 m and the width ranges between 1 m – 2 m.

Design the floor of the standings

Floors should be non-slip, and non-porous. Resistant to abrasion, impact, corrosion, and acid attack, the floor shall not crack or flake or dust and shall be durable. For the health and comfort of both persons and animals, suitable damp-proofing treatment should be provided.

Referring to IS 11786 (1986) depending on materials used in laying of floor the slope of the floor is to be decided.

Designing of structural members Construction of walls

The wall can be built using bricks, hollow concrete blocks

Construction of pillars

The pillars are constructed by using materials viz., Brick, Timber, Stone, slab, and Iron pipes.

Design of roofs

The height of the roof was estimated by determining the amount of ventilation required for the optimum climatic conditions inside the structure. The pitch of the roof may be ranged from 22° to 30°. An adequate number of air inlets should be provided on side walls. Also, sufficient outlets should be provided at or as near as possible to the roof for proper ventilation.

IV. EXPERIMENTAL RESULTS Galvanized Iron Naturally Ventilated Polyhouse of 200 sq.m floor area

The polyhouse was designed for the Konkan region and can sustain a wind velocity of 44m/s (158.4 km/h). The ventilation area of the polyhouse was 25% of the floor area i.e., 50 m². The length of the polyhouse is 20m and the width is 10m. The center height of the structure is 4.5m. The spacing for the top vent is designed as 0.5m. A door of the size 2m × 1m was used. The specifications of the polyhouse structure of 200 sq.m floor area are tabulated in Table 1

Table 1 Specifications of polyhouse of area 200 sq.m

Sr. No.	Title		Unit
1.	The floor area of the structure	200	m ²
2.	Ventilated area	50	m ²
	Height of side vent	0.675	m
	Height of ridge vent	0.15	m
3.	Design of columns		
	Uplift pressure	-1114.72	N/m
	Downward load	557.36	N/m
4.	Design of purlins		
	Dead load		
	Weight of poly film	3.010	N/m
	Weight of purlins	50.031	N/m
	Total dead load	53.04	N/m
	Live load	670.8	N/m
	Wind load	1869.38	N/m
5.	Design of columns		
	Load on pillar	5.863	KN
	cross-sectional area of pillar	0.586	cm ²
6.	Design of foundation		
	Diameter of pit	0.25	m
	Depth of footing	0.68	m
	Depth of foundation below ground level	0.60	m

Fig. 1 shows the front view of the designed structure and Fig 2 shows the side view of the structure.

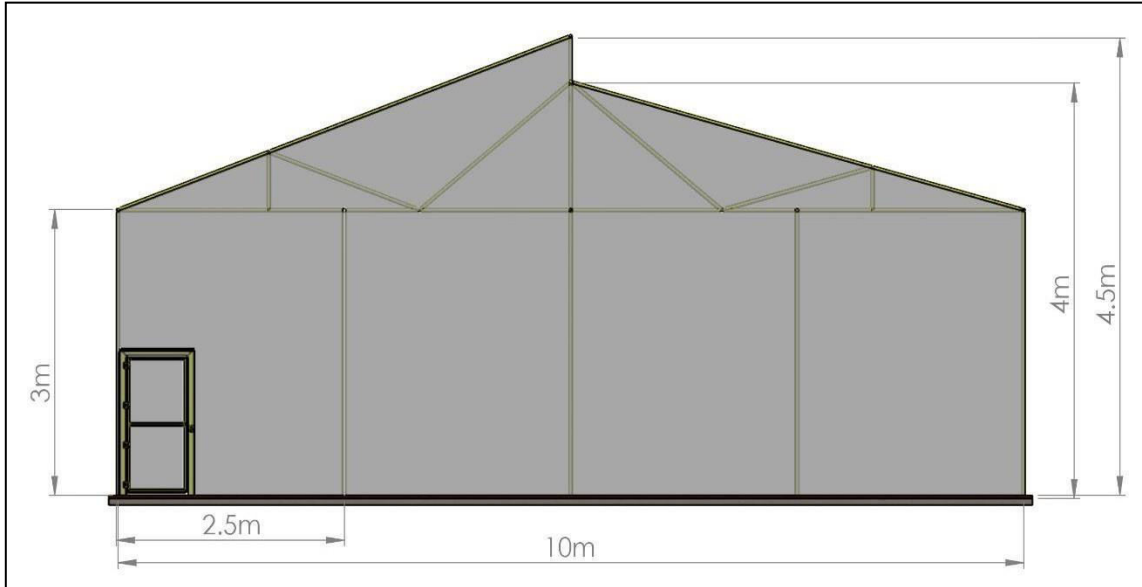


Fig. 1 Front view of the polyhouse

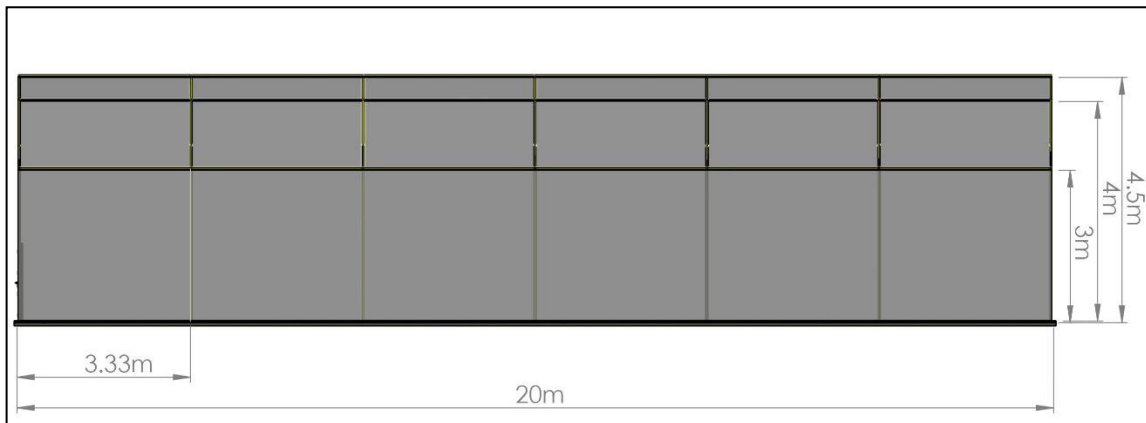


Fig. 2 Side view of the polyhouse

The total estimated material required for the erection of the structure is mentioned in Table 2

Table 2 Material estimates for G.I. naturally ventilated Polyhouse of 200 sq.m floor area

Sr. No.	Material	No.	Quantity required	Per
1	Cement for foundation	-	10 bags	Bag
2	20 mm Aggregates foundation	-	1880 kg	Kg
3	Sand for foundation	-	1100 kg	Kg
4	Tor bar of 8 mm dia. for hold-fast of column 0.45 m long	26	5 kg	Kg
5	Columns 48.3mm outside dia. GI Pipe 3.9 m long	26	101.4 m	m
6	Principal rafter 33.7 mm outside dia. GI Pipe 3.35 m long	24	80.4 m	m
7	Main tie 33.7 mm outside dia. GI Pipe 6 m long	12	72m	m

Sr. No.	Material	No.	Quantity required	Per
8	Main strut 33.7 mm outside dia. GI Pipe 0.854 m long	24	20.4m	m
9	Main sling 33.7 mm outside dia, GI Pipe 1.869 m long	24	44.84m	m
10	Purlins 60.3 mm outside dia. GI Pipe 16.66 m long	6	100m	m
11	Side Purlins 44.2mm outside dia. GI Pipe 16.66 m long	8	200/-	m
12	Low-density polyethylene UV stabilized 200-micron film 16.66m x 2.83 m 6m x 3 m 16.66 m x 3.354 m	4	188.58 m ²	-
		4	72 m ²	-
		4	223.50 m ²	-
			484.08 m ²	-
			24.20m ²	-
	Total		508.28	m ²
13	insect net for the side vent 16.66 m xo .67 m	4	44.64 m ²	m ²
14	Aluminium profile	12	200m	-
		4	24m	-
		Total	224 m	m
15	Spring		336 m	m
16	Door		2 x 1 m	-
17	Excavation for column Pits	26	m ³	m ³

Dairy barn for 72 animals

The structure was designed for a herd of 72 animals. The designed structure can withstand wind velocity of 44m/s (158.4 km/h). The length of the dairy barn is 40m and the width is 13m. The center height of the structure is 4.5m and the eaves height is 2.5m. The specifications of the Dairy barn are tabulated in Table 9.

Table 9 Specification of a dairy barn for 72 animals

Sr. No.	Title		Unit
1.	Herd size	72	No.
	No. of milking animals	20	No.
	No. of dry animals	10	No.
	No. of heifers	25	No.
	No. of bulls	1	No.
	No. of bullocks	1	No.
	No. of young males	2	No.
	No. of calves	13	No.
2.	The calculation for milking animal's standings		
	Length of cattle resting area	12	M
	Width of cattle resting area	5.2	M

Sr. No.	Title		Unit
3.	Calculation of dimension of standings		
	Length of cattle resting area	3	M
	Width of cattle resting area	4	M
4.	Calculation of dimension bull shed		
	Length of ration room	3	M
	Width of ration room	4	M
5.	Calculation of dimension of artificial insemination laboratory		
	Length of laboratory	3	M
	Width of laboratory	4	M
6.	Calculation of dimension of ration room		
	Length of ration room	3	M
	Width of ration room	4	M
7.	Overall dimensions of dairy barn		
	Length of barn	40	M
	Width of barn	13	M
8.	Design of purlins		
	Dead load		
	Weight of purlins	50.031	N/m
	Total dead load	50.031	N/m
	Wind load	1869.38	N/m
9.	Design of columns		
	Load on pillar	5.863	KN
	Cross-sectional area of pillar	0.586	cm ²
10.	Design of foundation		
	Diameter of pit	0.25	m
	Depth of footing	0.68	m
	Depth of foundation below ground level	0.60	m

Fig. 15 shows the front view of the designed structure and Fig 16 shows the side view of the structure.

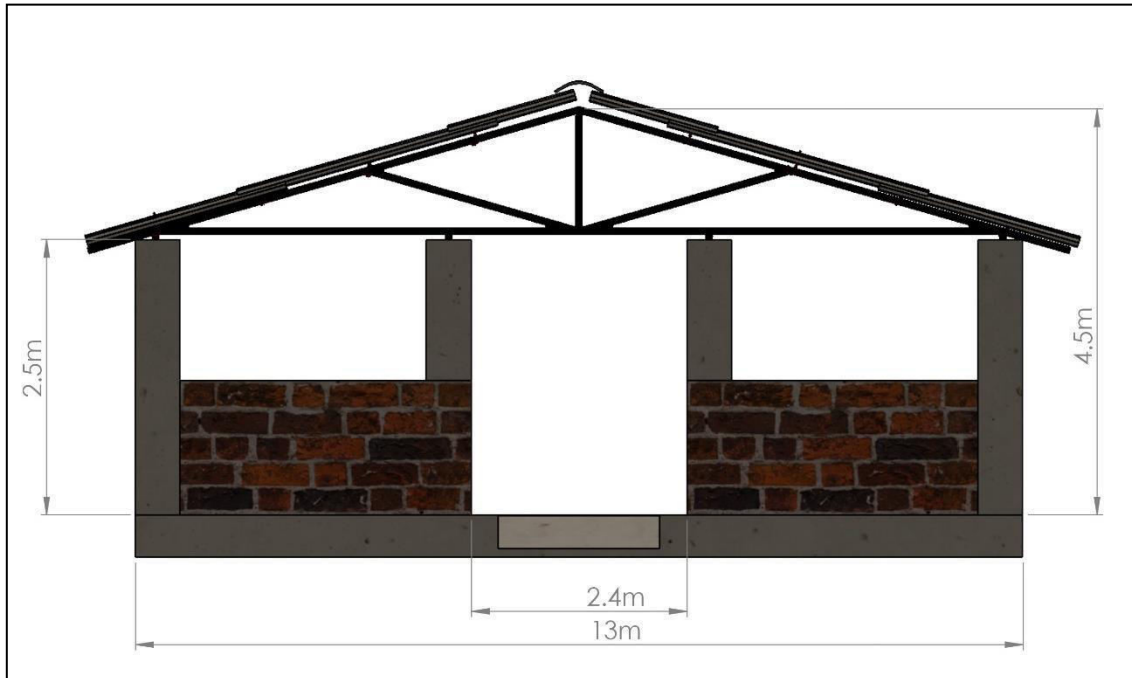


Fig. 15 Front view of the dairy barn

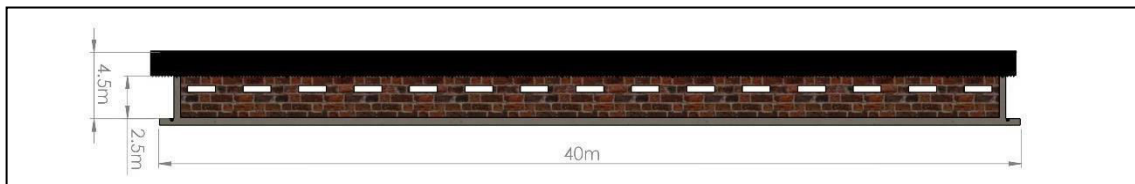


Fig. 16 Side view of the dairy barn

V. CONCLUSION

1. The polyhouse structure and dairy barn structure are designed to withstand wind speeds of 44m/s (158.4 km/h).
2. The estimated cost for designed polyhouse of 200sq.m floor area was Rs. 243950/-.
3. Dimensions for dairy barn structure were found to be as length 40m, width 13m, eaves height 2.5m, central height 4.5m, angle of roof 30°.
4. All the G.I. pipes used were of thickness 4 mm

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