PHILIPPINE NATIONAL STANDARD

PNS/PAES 419:2015
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ICS 65.040.20

Agricultural structures – Warehouse for bag type storage of grains

BUREAU OF PRODUCT STANDARDS*

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***BUREAU OF PHILIPPINE STANDARDS**

National Foreword

The Philippine Agricultural Engineering Standards PAES 419:2015, Agricultural structures – Warehouse for bag type storage of grains was approved for adoption as Philippine National Standard by the Bureau of Philippine Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (PCAARRD-DOST).

This standard cancels and replaces PNS/PAES 419:2003 (PAES published 2000).

Foreword

The revision of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Development of Standards for Rice Production and Postproduction Machinery" which was funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) of the Department of Science and Technology (DOST).

This standard has been technically prepared in accordance with PAES 010-2 – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate mandatory requirements to conform to the standard.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

In preparation of this standard, the following documents/publications were considered:

ASAE S337.1 FEB03 – Agricultural Pallet Bins

Codex Standard for Rice. 198-1995

National Food Authority. Technical Research Services. Quality Assurance Manual.2005 Edition.

Primer on Philippine Grains Standardization Program of the National Food Authority.

Rice Postharvest Technology. 1995. The Food Agency Ministry of Agriculture, Forestry and Fisheries. Tokyo, Japan.

Rice Postproduction Technology A Technical Reference Guide. 2003. Philippine Rice Postproduction Consortium. Japan Grain Inspection Association. National Food Authority. Quezon City.

Storage. IRRI Rice Knowledge Bank. (http://www.knowledgebank.irri.org/step-by-step-production/postharvest/storage)

1 Scope

This standard specifies the functional requirements for warehouses for bag type storage of grains. It does not include storage for seeds.

2 Definitions

2.1
aeration
moving of air through stored grains at low airflow rates between 0.05 – 2.28 cubic meter per minute per ton for purposes other than drying, to maintain or improve its quality

2.2
bag type storage
storing of paddy, milled rice, corn, and other grains in bags usually made of jute, polyethylene, and other packaging materials.

2.3
dunnage
pallet
"tarima"
wooden or plastic (food grade) frames used on concrete floors for stacking bags to prevent direct contact between the grains and the floor

2.4
fumigation
process of using chemicals to control insects in grains in a form of fumes

2.5
moisture content
amount of water in the grains, expressed as percentage

2.6
paddy
rough rice
"palay"
unhulled grain of *Oryza sativa*, which means, grain with the glumes enclosing the kernel

2.7
warehouse
building used for storing paddy, milled rice and other grains in bags, typical warehouse is shown in Figure 1.

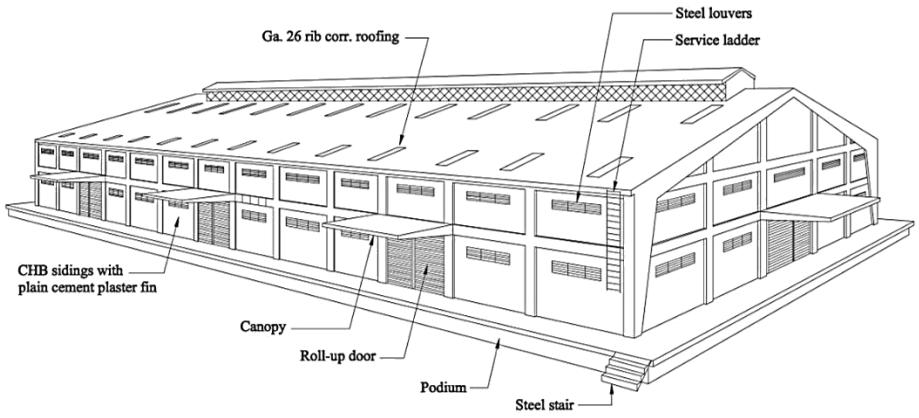


Figure 1 – Typical warehouse for bag type storage of grains

3 Location

3.1 It shall be accessible to all forms of transport system. There should be ample space to facilitate movement and manoeuvring of vehicles within the location.

3.2 The site shall be dry and located at areas that are free from flooding.

3.3 It shall be free from fire hazard.

3.4 The long axes of the warehouses should be oriented East-West or sited across the prevailing wind.

3.5 Warehouses shall not be located near busy public facilities such as schools, hospitals, etc. Surroundings in the vicinity shall conform to existing safety and sanitary measures.

3.6 The structure shall be built on a stable ground soil.

3.7 Space shall be provided for future expansion.

3.8 Electricity, communication, water services and drainage shall all be available and reasonably economical.

4 Functional Requirements

4.1 Product sectionalism

4.1.1 Warehouse operations shall be identified and analysed as to space requirements of the commodity and the in-out flow of stocks from one operation to another and identify the proper places of every operation.

4.1.2 The internal layout of the depot shall be designed in accordance with the First in -First out method of holding inventory.

4.1.3 Quality and quantity of the stored grains should be monitored.

4.2 Floor area requirement

4.2.1 Pallet dimension

The recommended dimension for the pallet to be used is shown in Table 1.

Table 1 – Recommended dimension for pallet

Shape	Dimension
Square [1]	152 cm x 61 cm
Rectangular [2]	120±1cm x 100±1cm x 72±1cm
Square [2]	120±1cm x 120±1cm x 72±1cm

[1] – National Food Authority
[2]– ASAE S337.1 FEB03

4.2.2 System of piling

4.2.2.1 Small scale storage

Bags of grain in each lot should be stacked in basic patterns of cluster formation (Figure 2) for easy inventory and quality maintenance/assessment.

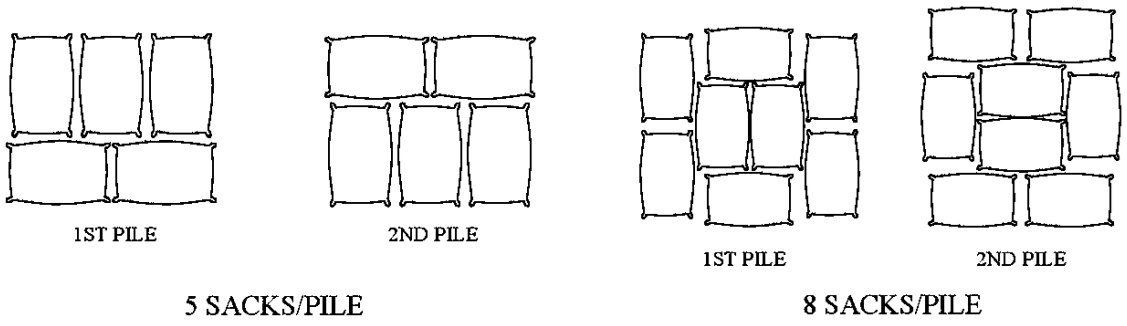


Figure 2 – System of piling for small scale

4.2.2.2 Large scale storage

4.2.2.2.1 Block stacking

In this type, six blocks are formed to make standard stack of 9.14m x 6m size. Each block is of the size 6m x 1.5m. In the block, one layer is put lengthwise and other breath-wise.

4.2.2.2.1.1 Chinese method

Bagged grains with 14% moisture content or lower could be piled in Chinese method. Sacks are piled side by side and one on top of the other for appropriate pest control measures (Figure 3).

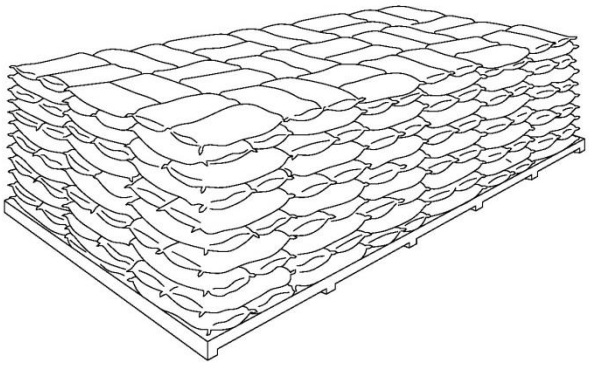


Figure 3 – Chinese piling

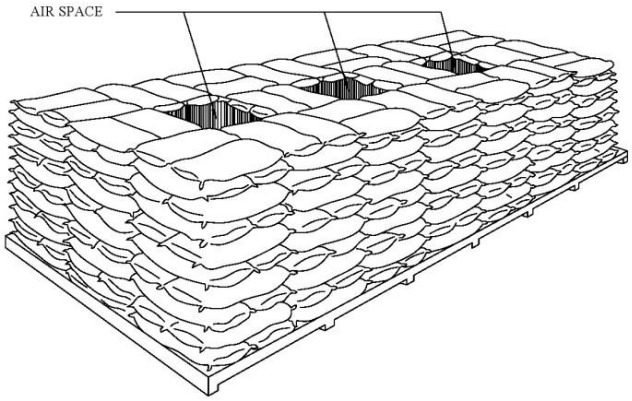


Figure 4 – Japanese piling

4.2.2.2.1.2 Japanese method

Bagged grains with moisture content 14.1% to 15% are to be piled in this method. This system of stacking provides ventilation space between bags and allows circulation of convective air currents that provide a medium for heat dissipation (Figure 4).

4.2.2.2.2 Criss-cross stacking

In this type bags are laid in complete length-wise or breath-wise tiers in alternate layers systematically. The first layer will have 11 bags in 9.14m direction with 11 such rows. The second layer of bags would be laid width-wise with 16 bags in 9.14m direction of stack with7 such rows.

4.2.3 Stack height

4.2.3.1 The height of stacks shall not exceed the height of the walls and a space of at least 1 m shall be allowed between the tops of the stacks and roof frames.

4.2.3.2 Sacks made of woven polypropylene have a tendency to slide on each other, and therefore shall not be stacked more than 3 m high. Jute sacks bind together better, and maybe stacked up to 6 m above the floor.

4.2.3.3 Factors like nature of grain, size, weight, and shape and strength of grain bag to stand the height of stack have direct bearing on stack height. Table 2 shows the optimum stack heights recommended for grain storage.

Table 2 – Recommended stack heights

Type of grain	Maximum stack height inlayers	Stack height, m
Wheat, barley and corn	18	4.57
Paddy	16	6
Rice	16	5.5

4.2.3.4 The size of the piles should conform with fumigating sheets in situations where warehouses cannot be made airtight. Dimensions for maximum piling should be7.3m x 21.9m x 4.5m.

4.2.3.5 Piles should be tight, neat and squared off.

4.2.3.6 The recommended bag warehouse capacity is shown in Table 3.

Table 3 – Recommended stacking density

Stacking Density	Number of bags per cubic meter
Paddy	10
Rice	15
Corn	12

4.2.4 Pathways

4.2.4.1 A central pathway should be 2 m wide or not less than 1m wider than the width of the widest forklift trucks that are being used simultaneously during warehouse operation.

4.2.4.2 If there is a forklift or mechanical handling equipment to be used, the central pathway should be designed with a width of not less than 0.6m wider than the width of the widest vehicle loaded.

4.2.5 Side spacing

4.2.5.1 Space between piles shall be 1m wide.

4.2.5.2 A minimum of 1m space between the edge of the pile and the wall shall be provided.

4.3 Physical dimensions of structure

Table 4 – Warehouse dimensions based on the number of bags

Number of bags (1 bag = 50kg)	Dimensions
10,000	10 m x 30 m
30,000	16 m x 48 m
50,000	20 m x 60 m
100,000	25 m x 78 m
500,000	75 m x 142 m

NOTE There may be special designs of warehouse for irregular shaped lot.

Given the recommended dimensions of the warehouse and its corresponding capacity above (Table 4), the number of buildings is doubled, tripled or quadrupled based on the desired capacity of the warehouse. For example a 200,000 bags warehouse is required, two buildings (duplex) with dimensions of 25m x 78m each is recommended.

4.4 Height of structure

The recommended height between the eaves line and the floor is 7 m and 2.5 m between the eaves line and the apex.

4.5 Building structure requirements

4.5.1 There shall be provisions for water tightness, to prevent moisture from leaching to the grain.

4.5.2 There shall be provisions for efficient loading and unloading bays.

4.5.3 There shall be provisions for aeration.

4.5.4 There shall be provisions for bird and rodent proofing and for fumigation.

4.5.5 The building shall have a clear inside span and has no inside pillars which could obstruct stacking arrangement.

4.5.6 The building should have a ledge or podium.

4.6 Illuminations

There should be provisions for sky lightings. Skylights should be placed in the aisle.

4.7 Electrical works

Receptacles for transporting equipment and wire distribution for electric fans shall be provided. If possible, conduit tubes shall be used. Electrical works should conform with the Electrical Code of the Philippines.

4.8 Drainage

Sufficient drainage shall be provided to prevent flooding.

5 Structural Requirements

5.1 Foundation

The construction shall conform with the National Building Code.

5.2 Floor

5.2.1 The floor should be adequately strong and capable of withstanding heavy loads and vibrations.

5.2.2 The floor shall be elevated or constructed higher than the existing ground. The floor should be 1m above the ground to permit easy loading or unloading into trucks at the sides of the warehouse.

5.2.3 There shall be provisions for wear resistance and safety (refractoriness and elimination of skidding risks).The floor should be smooth and easy to clean. It should be free from cracks where moisture from the ground may affect the stored grain. Moisture sealing compound or asphalt should be provided to fill the floor cracks against moisture.

5.2.4 Foundation, pillars and beams should be made from reinforced concrete. Floor construction should conform with the National Building Code.

5.3 Walls

5.3.1 The internal surfaces of the walls shall be smooth and free from projections to eliminate dust-laden surfaces, facilitate cleaning of the warehouse.

5.3.2 Gravel concentrations in concrete walls, protruding brick work, horizontal planes or rims, window sills, protruding door or window posts and other ledges should either be avoided completely or be shedded at a minimum angle of 60°.

5.3.3 The walls shall be painted white, on the inside to facilitate the detection of insect pests and on the outside to help keep the warehouse look as cool as possible and for sanitary purposes.

5.3.4 There shall be no opening between wall and roof.

5.3.5 A water/damp-proof barrier should be incorporated into the base of the walls. Waterproofing compound should be incorporated during the plastering and finishing of the walls.

5.3.6 A concrete strip about 1 m wide shall be laid around the warehouse to prevent rain from eroding the base of the walls below the damp course.

5.3.7 Wall construction should conform with the National Building Code.

5.4 Roof

5.4.1 Internal pillars supporting roof frames shall be avoided because it can interfere with the pest control and other stock management procedures. A standard roof truss of 14.5mspan (or larger) should be used.

5.4.2 Roof frames made of wood or steel shall be designed so that they transfer the weight of the roof to the supporting columns or to the walls.

5.4.3 It must be provided with the necessary lateral and vertical wind brace to resist forces due to strong winds and earthquakes.

5.4.4 The strength of the roof construction should be sufficient to handle the weight of the strongest winds that can be expected.

5.4.5 The roofing materials made of galvanized iron sheets and shall be in light colors (white or beige).The external surface should be reflective or light colored to minimize the amount of heat that it can absorb.

5.4.6 The chosen materials may be fire proof and with refractory.

5.4.7 The inclination of the roofs should be sufficient to drain rainwater quickly, taking into account that the water may be forced up by the wind.

5.4.8 Rainwater drainpipes should be closely spaced, of sufficient size and installed without bends.

5.5 Doors

5.5.1 There shall be at least two doors so as to be able to rotate stocks on a first in, first out basis.

5.5.2 The door shall be wide for easy access, yet fit tightly for insect control and fumigation. Roll up doors are generally used because of its capability to close tightly.

5.5.3 Preferably the door shall be made of steel or at least reinforced along their lower edges with metal plate as protection against rodents.

5.5.4 If sliding or folding doors are fitted, they shall be opened outwards in order not to reduce the storage capacity of the warehouse.

5.5.5 The size of the entrance is 6 m wide and 4 m high for normal temperature warehouse.

5.5.6 A canopy shall be constructed over every entry door to allow continuous loading and unloading even when it rains.

5.6 Ventilation

5.6.1 Vents should be provided near the floor level, at the top of the walls near the grid line and at the top of the roof and the ridge.

5.6.2 Ventilation openings such as louvers shall be fitted on the outside with anti-bird grills (20mm mesh) and on the inside (10 cm behind the grills) with insect screens (removable for cleaning), which will deter most insects.

5.6.3 Adequate natural ventilation openings shall be provided with shutters so that ventilation may be controlled.

5.6.4 Continuous ridge vent are built on the roof top which provide good ventilation in addition to the louvers all over the warehouse.

5.6.5 In addition to natural ventilation exhaust fans should be installed.

5.7 Rodent proofing

If the structural set-up of doors is unsatisfactory the rodent barrier may be attached. An iron sheet used for rodent barrier should have an optimum size but will not obstruct the entrance and will not impede mobility. As shown in Figure 5, its height should be little over 60 cm and fixed by a mortise and tenon joint or by hinge. Polished artificial stone is usually used for wall rodent barrier.

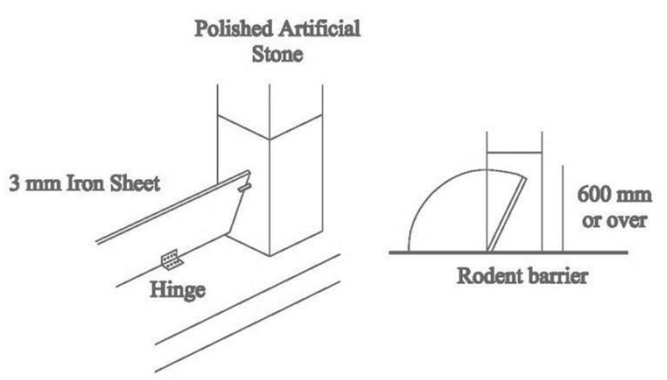


Figure 5 – Rodent barrier

On all possible entries within the warehouse, there should be a screen for bird and rodent control.

6 Warehouse Management

6.1 Fumigation

In cases of insect infestation and presence of mold, fumigation should be carried out. The appropriate pest control should be used for insect pests or microorganisms. During fumigation dosage of the chemical and airtight conditions must be carefully observed.

Fumigants should be kept in a special locked storage room.

6.2 Facility requirement

6.2.1 Quality control laboratories

6.2.2 Workshops

6.2.3 Garage for vehicles

6.2.4 Dead stock store

6.2.5 Bag stacker

6.2.6 Pest control chemicals store

6.2.7 Isolation shed

6.2.8 Restrooms and washing facilities and accessible facilities

6.2.9 Personnel office

6.3 Safety

6.3.1 Guards for machines should be provided.

6.3.2 Illuminations should be sufficient and should have a cover guard.

6.3.3 Warning signs or boards shall be fixed in hazardous/dangerous places and exits and must be visible on other places.

6.3.4 There shall be a provision for fire control equipment as provided in the National Building Code.

6.3.5 There shall be provisions for first aid kit.

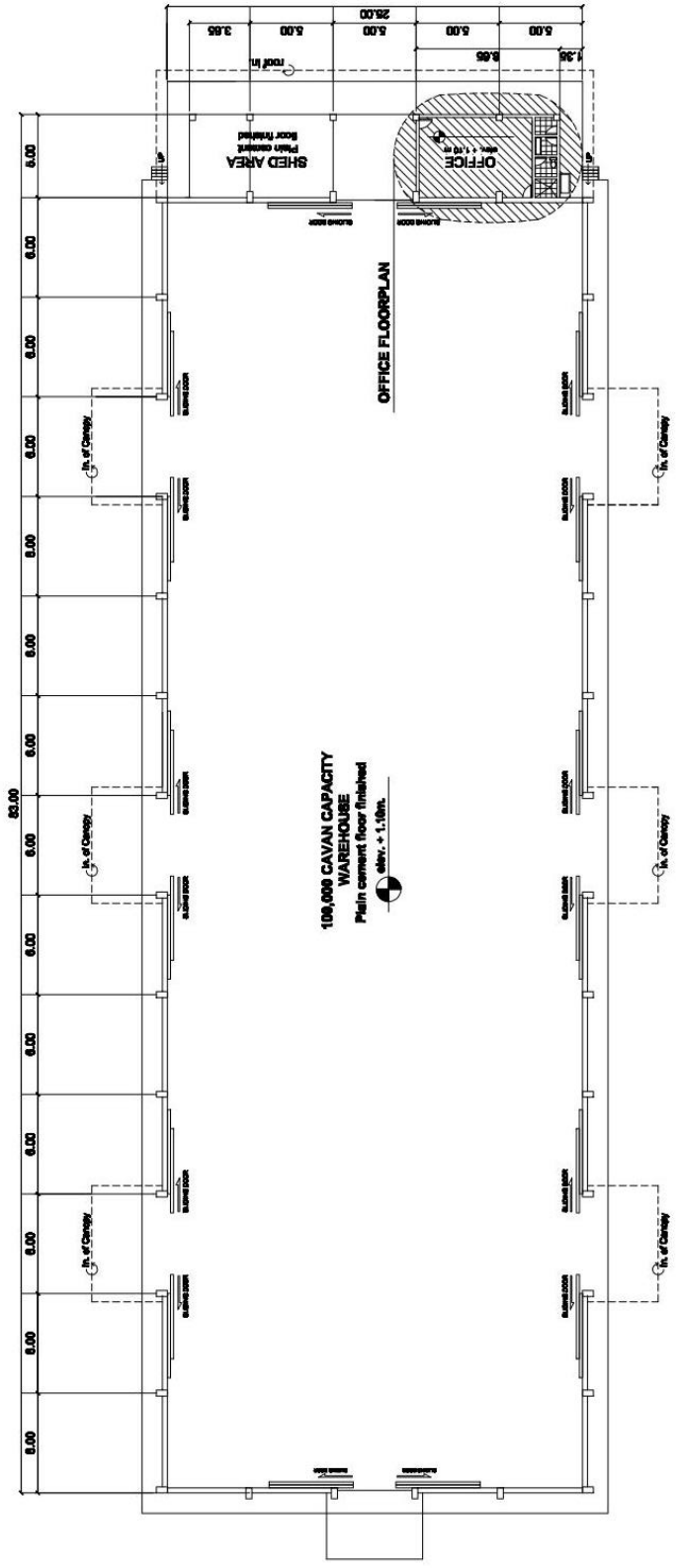
6.3.6 There shall be provisions for proper exhaust and ventilating system.

6.4 All warehouses shall be identified by their warehouse name, code and location printed on a standard billboard exhibited outside the warehouse.

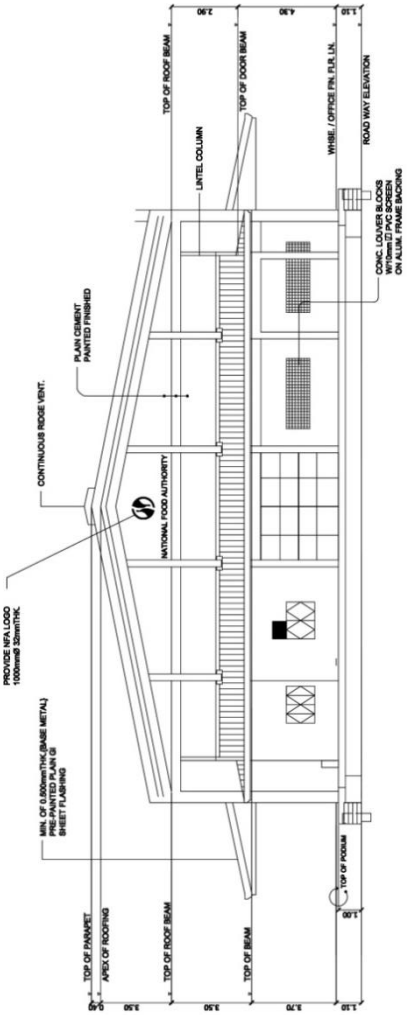
ANNEX A
(Informative)

Sample Design of a Standard Warehouse
(Capacity 100,000 bags)

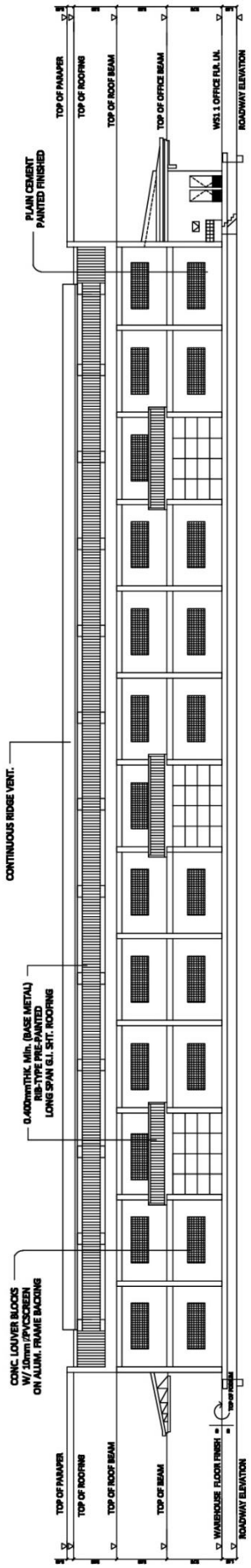
A.1 Floor Plan



A.2 Elevation



FRONT ELEVATION
DRAWN NOT TO SCALE



LEFT SIDE ELEVATION
DRAWN NOT TO SCALE

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