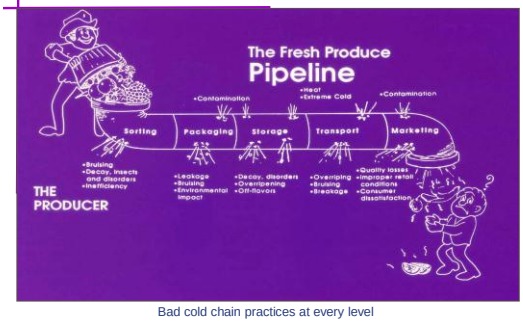
SUPCO WORKSHOP
MODERN ENERGY EFFICIENT COLD STORAGE CONSTRUCTION & INSULATION SYSTEM

K.K. MITRA - VICE PRESIDENT
LLOYD INSULATIONS (INDIA) LTD.

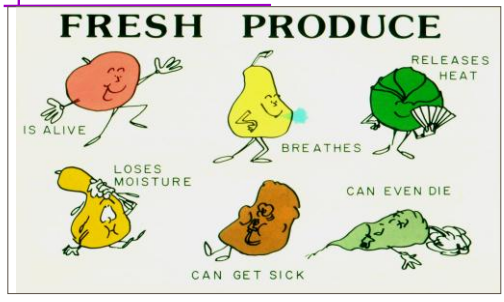
AN INCONVENIENT TRUTH



Courtesy : Dr. A. Kader

Bad cold chain practices at every level
Customer (The ultimate sufferer)

THE NEED & NECESSITY
Cold Storage Development For Perishables



Courtesy : Dr. A. Kader

Treat a commodity like human being

WHAT IS THE EXISTING SITUATION

- Not efficient / Attempting efficiency – Cold Chain Practice.
- Voluminous produce – limited availability
- Quality not so good always
- Set back to Growers – imports
- Product Wastage on field
- Not proper / efficient storage

IMPROPER COLD STORAGE

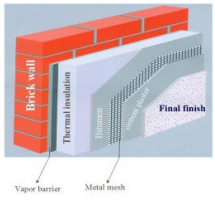
INSULATION PURPOSE

- Initially when Cold Storage starts, Refrigeration equipment brings down temp.
- **Subsequently insulation maintains the temperature.**

CONVENTIONAL COLD STORE

The basic rules for insulation system are :

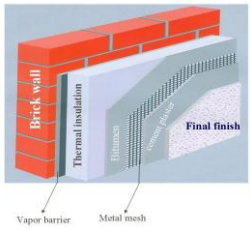
- Using good insulating material having a high insulating value, characterized by a low thermal conductivity
- Protection to the insulant against vapour ingress, by providing a Vapour Retarder applied directly to the wall to restrict migration of ambient atmospheric moisture into the cold room interior.



- Use an interior lining on insulation essentially to prevent mechanical damage

Plaster+Brick+Plaster+VB+Insulation+Finish
Approx. 360mm wall

EXISTING COLD STORE – PROBLEMS, CONVENTIONAL PRACTICE



Sequential application of vapor barrier, insulation & plaster finish

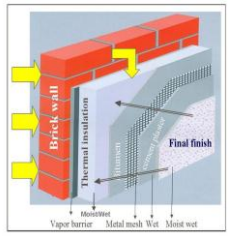
What about moisture ingress from inside & life of plaster finish

Basic Thermal & Civil Engg. Design problem

EXISTING COLD STORE – PROBLEMS

CAUSES OF THERMAL INSULATION SYSTEM FAILURE

- Continuous moisture ingress through plaster
- Insulation becoming wet & resistivity decreases
- Plaster chipping off
- Vapour barrier becomes weak
- Formation of cold spots
- Deterioration & failure of Thermal Insulation System

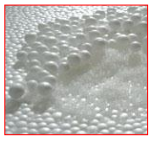


DOUBLE MOISTURE ATTACK

1 % OF MOISTURE INGRESS = 5 % REDUCTION IN 'R' VALUE

EXPANDED POLYSTYRENE (EPS) TECHNICAL SPECIFICATIONS

DENSITY	-	18 to 22 kg/m3. Higher densities available on request
Temperature range	-	- 200 deg.C to 80 deg.C
Thermal conductivity	-	The air entrapped within the minute closed cells impart to the material its extraordinarily low thermal conductivity 0.314 W/mK at 10°C mean temp.
Compressive Strength	-	0.7 to 1 kg/m2 at 10% deformation
Cross Breaking Strength		1.4 to 1.8 kg/m2
Water Absorption (after 24 hrs. immersion)	-	Less than 0.5% by volume



EXPANDED POLYSTYRENE (EPS) TECHNICAL SPECIFICATIONS

Chemical Inertness	-	Unaffected by water, acids, alkalies, alcohols and most oils of vegetable and animal origin. Soluble in aliphatic, aromatic and chlorinated hydrocarbons, ketones, esters, ethers, petrol, turpentine, concentrated sulphuric and nitric acids
Handleability	-	Easily cut with a knife and readily applied with solvent free bitumen and adhesive
Standard Sizes	-	Slabs – 1M x ½ M of thickness 25mm to 100mm Pipes – ½M length of thickness 15 to 150mm Other sizes and thicknesses available on request.
Draw backs	-	• Moisture gets entrapped between cells and ice formation, leads to failure gradually. • Low density • Poor compressive strength • Poor adhesion • Lower temp. rating

INSULATION LIFE

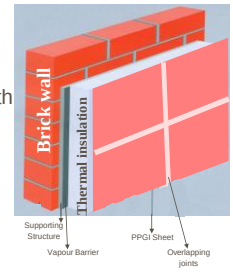
- Insulation needs to be properly fixed to surface
- Insulation needs to be covered & protected
- Cold Insulation needs vapour barrier on warm side

- **Cold storage Insulation needs vapour barrier on both sides to counter moisture attack on both sides.**
- Thermal Engineering issue

Suppose if Insulation is changed

Changing from Open Cell Structure to Closed Cell Insulation materials

- Polyurethane Foam Slabs with aluminium foil
- Cold adhesives
- Proper Thickness (70 ->85-90% RH)
- PPGI sheet finish
- Polymerized plaster



Suppose if Insulation is changed

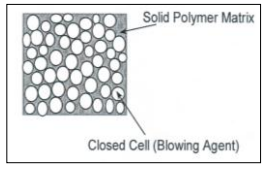
- Jointing problem will persist.
- PPGI sheet finish, conduction losses from back up support / cold spots
- Moisture ingress thru joints.
- Labour intensive application.
- Partial solution
- Poor aesthetics

☞ Polymerized plaster & PUF

Basics

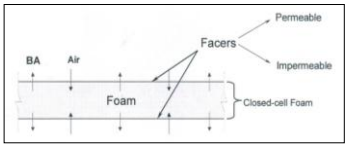
Polyurethane & Polyisocyanurate Foams :

- Manufactured out of a very fast chemical exothermic reaction between two chemicals in presence of a blowing agent resulting into a polymer matrix & gas filled closed cells all around



Basics

- Gas filled air cells has very low conductivity which reduces heat conduction
- Smaller size of cells reduces convection
- Every cell acts as a barrier to radiative heat loss
- Some air does enter the blowing agent cells and fills up thru aging
- Thermal conductivity slightly changes – aging (0.017 to 0.021 W/mK)



High Performance Closed Cell Insulation Material

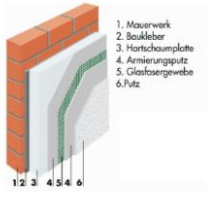
- **Polyurethane & Polyisocyanurate Foams -**
- Lowest thermal conductivity (0.021 W/mK)
- Adequate density (32-36 kg/m3 for Slabs, 40-45 kg/m3 for panels)
- Higher temperature rating (110-140 deg.C)
- Higher Resistance Values
- CFC, HCFC & ZERO ODP
- Low embodied energy
- Indigenously manufactured (within 500 kms. any site)
- Green Insulation – 5 Points

Basics

Extruded Polystyrene Foams :

- Light Petrochemical beads / globules compressed & cured with steam
- Expanded has permeable faces & Extruded partially / easily damageable impermeable faces
- Lower temperature ratings 70^0C (max.)
- Higher manufacturing / embodied energy
- Low density
- Extruded still primarily imported
- Primarily cold climate product

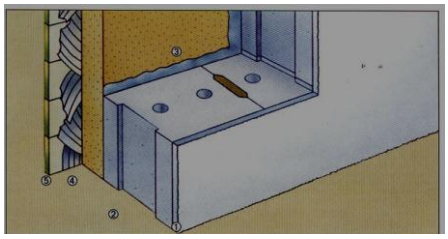
UPGRADED INSULATION SYSTEM



1) ***Masonry***
2) ***Adhesive***
3) ***Polyurethane/PIR Foam***
4) ***Basecoat***
5) ***Fiber mesh***
6) ***Top Coat***

ETICS : Upgrade conventional insulation practice

UPGRADED INSULATION SYSTEM



1. External Plaster
2. Bricks
3. Special adhesive for PUF
4. PUF Insulation slab
5. Polymerized Plaster or Tile

Insulation applied on Wall Existing Cold Stores

- Direct application of PUF insulation on plastered walls from inside or outside.
- Polymerized Plaster with reinforcement.
- Painting

Existing Cold Stores with sound civil construction – Revamping of Insulation

REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
APPLICATION OF PRIMER COAT

REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
APPLICATION OF ADHESIVE

REVAMPING OF EXISTING COLD STORES

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REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
FIXING OF SLAB ON TO THE WALL

REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
FIXING OF SLAB ON TO THE WALL

REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
STAGGERED JOINTS

REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
APPLICATION OF BASE COAT

REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
APPLICATION OF BASE COAT

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REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
FIXING OF REINFORCEMENT MESH

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REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
FIXING OF REINFORCEMENT MESH

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REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF / PIR SLABS
APPLICATION OF TOP COAT

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REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF/PIR (EXTERNAL)
FINAL FINISH

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REVAMPING OF EXISTING COLD STORES

WALL INSULATION WITH PUF/PIR (EXTERNAL)
FINAL FINISH

Insulation applied inside Existing Cold Stores

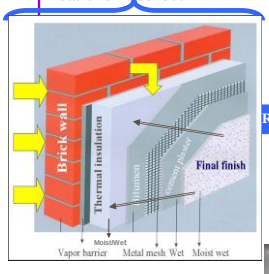
- Direct application of PUF insulation on plastered walls from inside.
- Polymerized Plaster with reinforcement.
- Painting

Existing Cold Stores with sound civil construction – Revamping of Insulation

What is the Solution to achieve efficiency in Cold Store construction

MODERN PRACTICE IN COLD STORE CONSTRUCTION

Total thickness: 360mm



Conventional

Replaced with

Thickness 80 to 100/ 150 mm.

PUF Panels

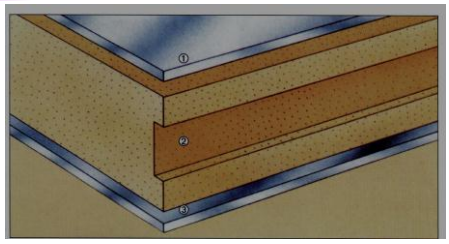
Modern

DESIGN TREND IN MODERN COLD STORES

MATERIALS :

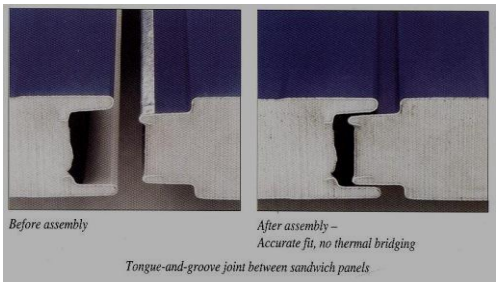
- Prefabricated Polyurethane Foam sandwich panel
- Metal sheet finish – solid barrier on both sides
- Energy efficient insulation
- Scientifically designed edges, camlocks
- Steel Structure / PEB

MODERN COLD STORE



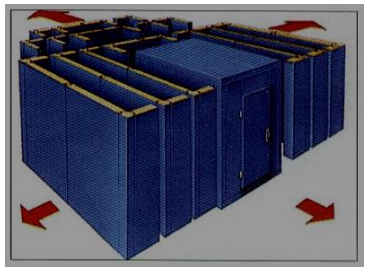
1. PUF Panel
2. Metal facing

MODERN COLD STORE



Tongue-and-groove joint between sandwich panels

MODERN COLD STORE



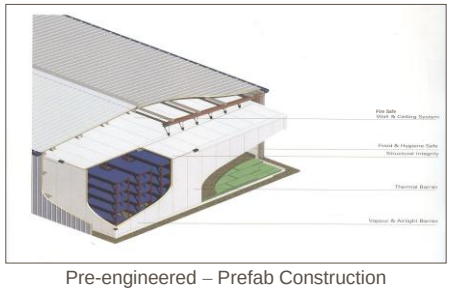
Modular Cold Store

DESIGN TREND IN MODERN COLD STORES

ADVANTAGES :

- Thermal & vapour barrier metal finish panels
- Easy to install
- Less labour intensive
- Fast construction
- Energy efficient
- In practice in India since 1994 / 97

Modern practices in cold store construction



Pre-engineered – Prefab Construction

Modern practices in cold store construction

- RCC work is replaced by steel columns and purlins – a *Pre-engineered Building Technology*.
- Brick walls & Insulation, False Ceiling with Insulation replaced by Polyurethane Sandwich panels directly fixed to the columns.
- 4-6 tiers can be formed of height 7 feet each.
- Maintaining an air gap of 1-2 feet on the sides and 4 feet for stair case.



Modern practices in cold store construction

Wall insulation is 80mm thick Rigid Polyurethane Foam Panel, with 0.5mm thick Colour Coated and Galvanized Sheet on both sides, with Tongue & Groove jointing detail and cam-lock arrangement.

Ceiling Panels are 100mm thick.

Floor is 60mm EPS as in Conventional System

or PUF slabs

Rain Guard profile sheet

Insulated doors

Energy Efficient Refrigeration system


Modern practices in cold store Features

Lloyd Panel System- Prefab Panels

Panel Dimensions

Length	:	12 mtr. (max.)
Width	:	0.6 – 1.2 mtr.
Thickness	:	50,60,80,100,120,150,200mm
Shape	:	Straight
		L shape for corners

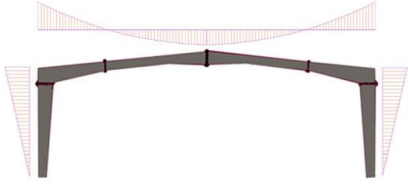

ELEMENTS OF A MODERN COLD STORE

PEB
Steel structure framing

PEB STEEL LLOYD Building for Life

PRE-ENGINEERED BUILDING STRUCTURE

Built-Up Section



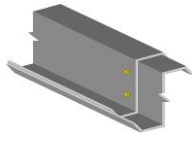
- PEB frames are tapered and flanges and webs often have variable thickness.
- The frame geometry matches the shape of the internal stress diagram, thus minimizing material waste and reducing the total weight.
- **Green Building Structure**

PEB STEEL LLOYD Building for Life

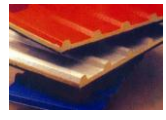
PRE-ENGINEERED BUILDING STRUCTURE

Built-Up Section

Purlin & Girt



Panel



Sheeting

PRE-ENGINEERED BUILDING STRUCTURE

PRE-ENGINEERED BUILDING STRUCTURE

LLOYD PANEL SYSTEM PREFAB SANDWICH PANELS

Camlock option

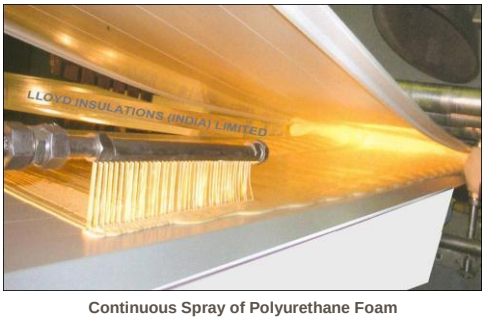
- Panels with both side metal facing acting as impermeable vapour barriers
- Avoids moisture coming in contact with insulation
- No deterioration of insulation
- Joints between panels sealed
- Moisture remains always over metal sheet
- Equilibrium situation leading to Energy Conservation
- CFC & HCFC free, zero ODP, cyclo Pentane blowing
- Length upto 12 mtr.
- **Green Panels – 5 Points**

LLOYD PANEL SYSTEM

- Automatic Plant
- Environment friendly
- Contimat

Mechanical product handling

PANEL MANUFACTURING



Continuous Spray of Polyurethane Foam

PANEL MANUFACTURING

DISCONTINUOUS CAMLOCKS

LLOYD PANEL SYSTEM

- Strict Quality Control
- Inhouse Lab

NABL
National Accreditation Board for Testing and Calibration Laboratories
Department of Science & Technology, India
CERTIFICATE OF ACCREDITATION
THERMAL INSULATION LAB OF ISOLLOYD ENGINEERING TECHNOLOGIES LTD.
has been assessed and accredited in accordance with the standard
ISO/IEC 17025:2005
"General Requirements for the Competence of Testing & Calibration Laboratories"
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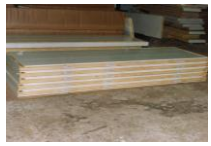
in the field of
MECHANICAL TESTING
Certificate Number T-1369
Issue Date 08/03/2008
Valid Until 07/08/2010
This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL
Signed for and on behalf of NABL
Alok Jain, Convener
Dr B. Hari Gopal, Director
Dr T. Ramasami, Chairman

LLOYD PANEL SYSTEM PREFAB SANDWICH PANELS

THERMAL & LOAD CHARACTERISTICS OF PANEL

Thickness	mm	60	80	100	120	150	200
'U' value	w/m2k	0.36	0.26	0.21	0.19	0.14	0.11
Panel weight	Kg/m2	11.25	12.05	12.85	13.65	14.85	16.85



LLOYD PANEL SYSTEM PREFAB SANDWICH PANELS

Properties of polyurethane foam

DENSITY	40± 2 kg/ m3.
Compressive strength At 10% deformation	2.1 kg/cm2
Tensile strength	3.7 kg/cm2.
Bending strength	4.0 kg/cm2.
Adhesion strength (Foam to steel)	2.9 kg/cm2.
Dimensional stability (48hrs) -25 DegC +38 Deg.C & 90 % RH +100 Deg.C	 0.1% 0.1% 0.4%
Closed cell content	90-95%
Temperature range	-180Deg.C to +110 Deg.C
CFC & HCFC FREE, ZERO ODP, CYCLO Pentane	

LLOYD PANEL SYSTEM PREFAB SANDWICH PANELS

Properties of polyurethane foam

Thermal conductivity at 10 Deg. C	0.020k-cal/m-hrdeg.C or 0.023 W/mK
Fire resistance Horizontal extent of burn BS 4735	<125mm.
Self extinguishing ASTM D 1692 (fire retarded foam chemical) Not easily ignitable as per BS 476 pt.5 & class 1 as per BS 476 pt.7 (for panel)	Passes
Water absorption	0.2% volume at 100% RH
Water vapour permeability (at 90%RH & 38Deg.C)	0.08-0.12 gms/hr m2
CFC & HCFC FREE, ZERO ODP, CYCLO Pentane	

LOWEST THERMAL CONDUCTIVITY
GREEN POINTS : 5

MODERN PRACTICES IN COLD STORE CONSTRUCTION

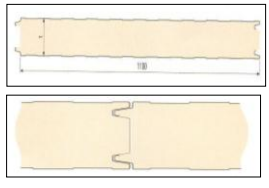
Main features of Lloyd Panel System –

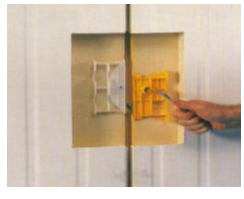
- A high strength to weight ratio, with significant savings in steel work and load bearing foundations, allowing large spans to be constructed with no intermediate columns.
- Dimensional stability.
- Maintenance-free surface.
- High thermal efficiency ensures low heat transmission, resulting in lower refrigeration load.
- No deterioration of thermal efficiency over time.
- Panels can be furnished in single jointless height / Length upto 12 mtrs. Partition wall can be easily erected as the panels are self supporting.

MODERN PRACTICES IN COLD STORE CONSTRUCTION

Main features of Lloyd Panel System –

- To arrest thermal leakage, joints are finished in tongue and groove configuration which in combination with optional CAMLOCKS ensures a foam to foam joint rather than a metal to metal joint.





MODERN PRACTICES IN COLD STORE CONSTRUCTION

Main features of Lloyd Panel System –

- Panel system incorporates special “L” shaped single piece panels for CORNERS. This avoids wall to wall direct jointing - provides additional stability, strength, aesthetical appearance, easy house keeping etc.
- For additional reinforcement “U/L” shaped flashing are provided at wall to ceiling joints.
- Rain guard profile sheet over ceiling panels

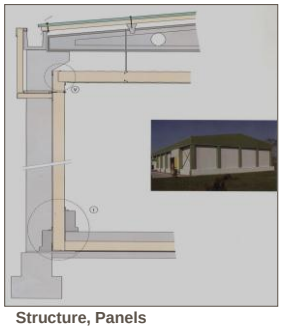
MODERN PRACTICES IN COLD STORE CONSTRUCTION

Main features of Lloyd Panel System –

- Proven in Indian conditions since 1994 & widely available - 20 million SQM per Annum

MODERN PRACTICES IN COLD STORE CONSTRUCTION

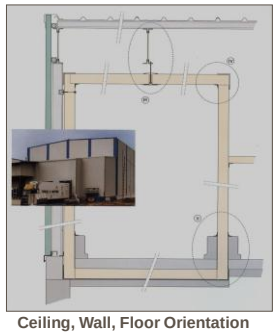
INSTALLATION PROCEDURE



Structure, Panels

MODERN PRACTICES IN COLD STORE CONSTRUCTION

INSTALLATION PROCEDURE

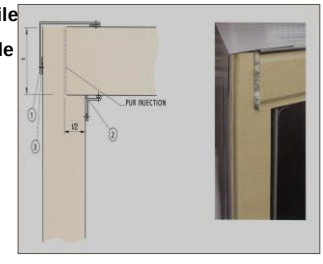


Ceiling, Wall, Floor Orientation

MODERN PRACTICES IN COLD STORE CONSTRUCTION

WALL – CEILING CONNECTION

1. **Outer Corner Profile**
2. **Inner Corner Profile**
3. **Sealant**



MODERN PRACTICES IN COLD STORE CONSTRUCTION

WALL – CEILING CONNECTION

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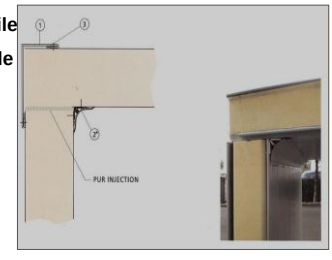
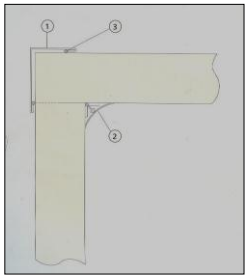
3. **Sealant**



MODERN PRACTICES IN COLD STORE CONSTRUCTION

Covings



Special arrangement

MODERN COLD STORAGE

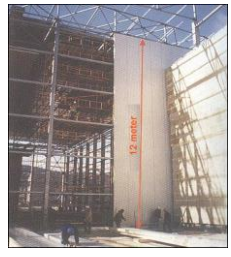
VERTICAL FIXING OF PANELS

MODERN COLD STORE

Lifting of panels for Wall

MODERN COLD STORE

Panel External Wall



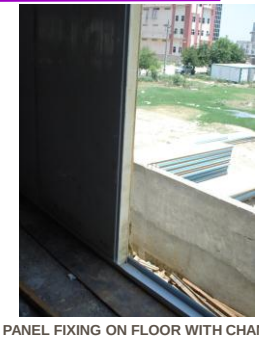
Max. single length 12M generally

MODERN COLD STORE

Panel External Wall

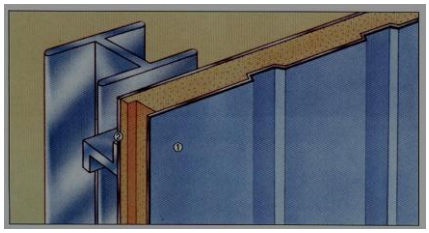
Max. single length 12M generally

MODERN COLD STORAGE



PANEL FIXING ON FLOOR WITH CHANNEL

MODERN COLD STORE



1. PUF Panel
2. Steel Purlin

MODERN COLD STORAGE

INSIDE VIEW

MODERN COLD STORAGE

INSIDE VIEW

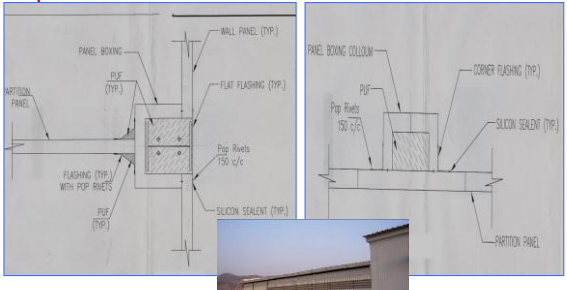
MODERN PRACTICES IN COLD STORE CONSTRUCTION

Panel Partitions

Multi Chambered Cold Stores

MODERN PRACTICES IN COLD STORE CONSTRUCTION

Wall Construction details with Panels

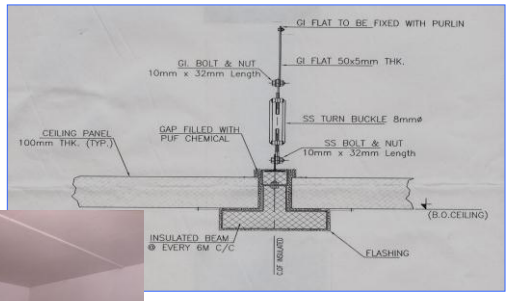


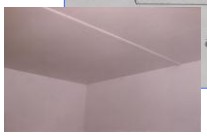
MODERN COLD STORAGE

WALL PANELS ERECTED

MODERN PRACTICES IN COLD STORE CONSTRUCTION

Roof Construction details with Panels

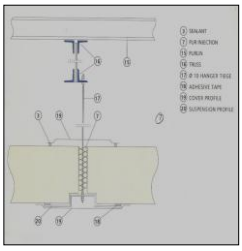




ENGINEERING DETAILS

MODERN PRACTICES IN COLD STORE CONSTRUCTION

Ceiling Panel

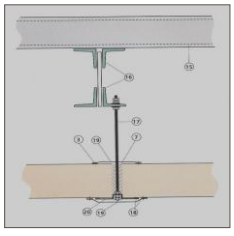


Panel to Hanger orientation

MODERN PRACTICES IN COLD STORE CONSTRUCTION

CEILING SUSPENSION SYSTEM

3. Sealant
7. PUR Injection
15. Purlin
16. Truss
17. Ø 10 Hanger Tiege
18. Adhesive Tape
19. Cover Profile
20. Suspension Profile



MODERN COLD STORAGE

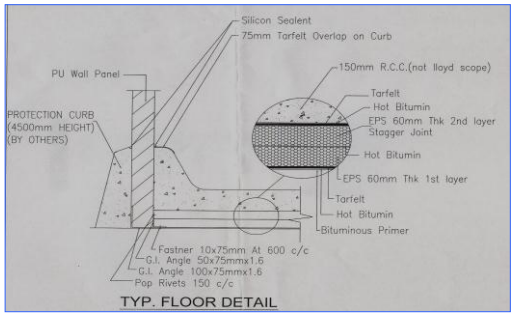
FIXING OF CEILING PANELS

MODERN PRACTICES IN COLD STORE CONSTRUCTION

Ceiling Panel

MODERN PRACTICES IN COLD STORE CONSTRUCTION

Floor Construction details



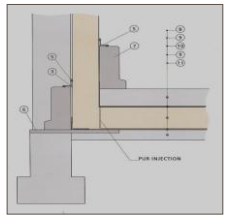
MODERN PRACTICES IN COLD STORE CONSTRUCTION

Floor Construction details

MODERN PRACTICES IN COLD STORE CONSTRUCTION

WALL FLOOR CONNECTION

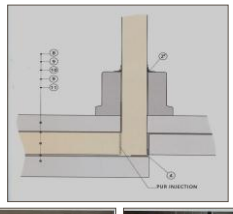
3. Sealant
4. L Profile
5. Bottom Border Profile
6. Plain Concrete For Slope
7. Protective Concrete
8. Reinforced Concrete
9. Floor Water Insulation
10. Floor Heat Insulation
11. Lean Concrete



MODERN PRACTICES IN COLD STORE CONSTRUCTION

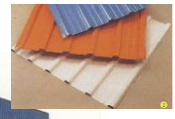
WALL FLOOR CONNECTION

2. Inner Corner Profile
4. L Profile
8. Reinforced Concrete
9. Floor Water Insulation
10. Floor Heat Insulation
11. Lean Concrete



MODERN PRACTICES IN COLD STORE CONSTRUCTION

- Rain Guard Profile Steel Sheet
- Exhaust Fan



COLD STORAGE CONSTRUCTION

Rain Guard

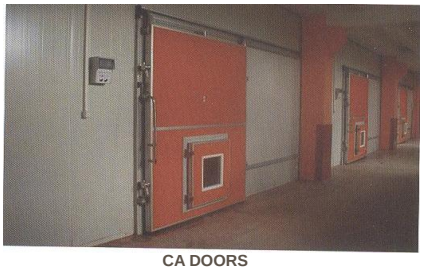
Colour Coated GI Sheet

MODERN COLD STORE

VARIETY OF DOORS

HINGE & SLIDING

MODERN COLD STORE



CA DOORS

MODERN COLD STORE

MOTORIZED DOORS

MODERN COLD STORE

SAFETY - FIRE SAFE PANELS

- Classified under Class-1 Construction
- Classified as Not Easily Ignitable according to BS : 476 Part-5
- Surface Spread of Flame Classification determined as Class-1 according to BS : 476 Part-7

MODERN COLD STORE

Environment Friendly

- Zero ODP PUF
- CFC, HCFC Free Rigid Polyurethane Foam
- Steel finish

MODERN COLD STORE

HYGIENE

- Panels does not allow growth of any Biological item
- Corners have flashings /covings to stop any dust deposition
- Panels are washable

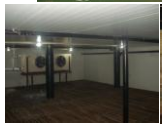
MODERN COLD STORE

REFRIGERATION LIGHTING SYSTEM

MODERN COLD STORE

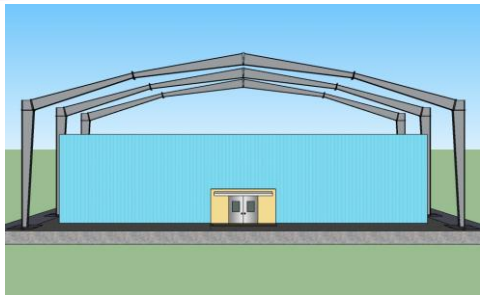
INTERIOR

MODERN COLD STORAGE



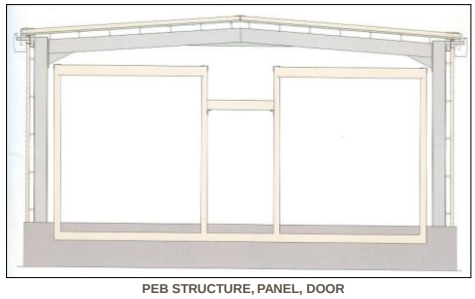
COMPLETED PROJECT
GREEN COLD STORAGE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



PEB STRUCTURE, PANEL, DOOR
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

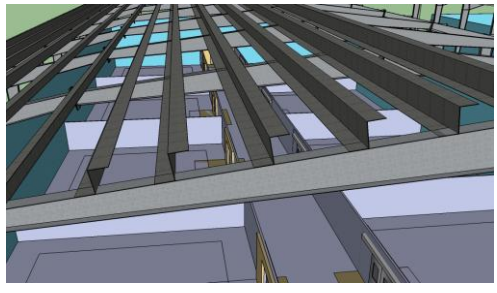


PEB STRUCTURE, PANEL, DOOR
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

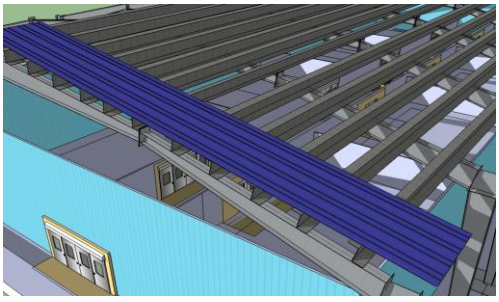
RAFTER & PURLINS
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



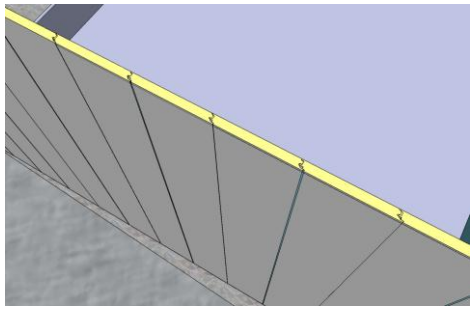
RAFTER & PURLINS
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



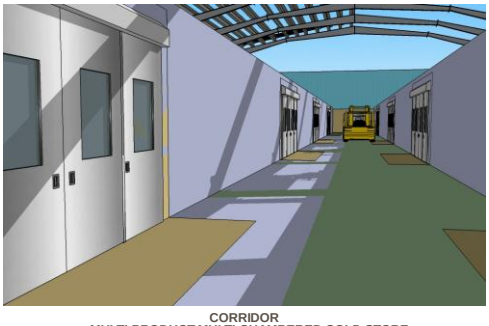
ROOFING SHEET OVER PURLINS – RAIN GUARD
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



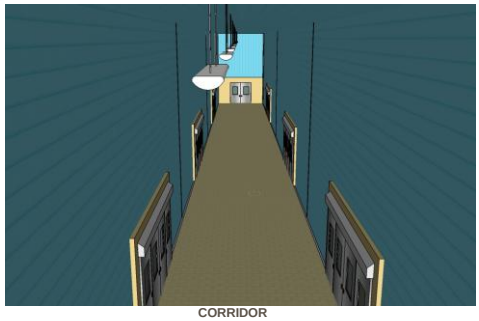
PANEL JOINTING
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



CORRIDOR
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



CORRIDOR
MULTI PRODUCT MULTI CHAMBERED COLD STORE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

VEHICLE PARKING

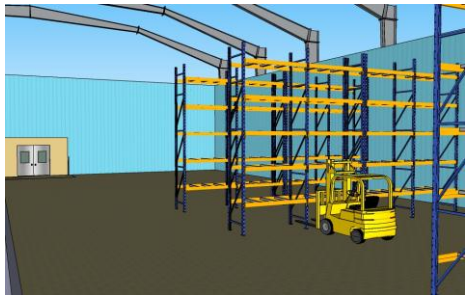
MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

VEHICLE PARKING

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

MULTI CHAMBERED CORRIDOR

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING



RACKING

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

PRODUCT STORAGE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

FIXING OF HORIZONTAL PANEL FROM INSIDE

CA STORAGE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

PANEL ERECTION PROCEDURE HORIZONTAL FIXING TO COLUMNS FROM OUTSIDE

MODERN PRACTICES IN COLD STORE CONSTRUCTION – CONTRACTING

HORIZONTAL PANEL ERECTION PROCEDURE

MODERN COLD STORE CONSTRUCTION

PEB & Panel erection complete
Green Cold Storage

MODERN COLD STORE CONSTRUCTION

COLD STORE SORTING GRADING

OFFICE SPACE

PEB & Panel erection complete
Green Cold Storage

MODERN COLD STORE CONSTRUCTION

PEB & PANELS

IMPRESSIVE FINISH & FAST CONSTRUCTION

MODERN COLD STORE CONSTRUCTION

PEB & PANELS, RCC COLUMNS

MODERN COLD STORE CONSTRUCTION

PEB & PANELS

MODERN COLD STORE FEATURES

LARGE CLEAR SPAN

MODERN COLD STORE FEATURES

LARGE INTERIOR SPACE

MODERN COLD STORE FEATURES

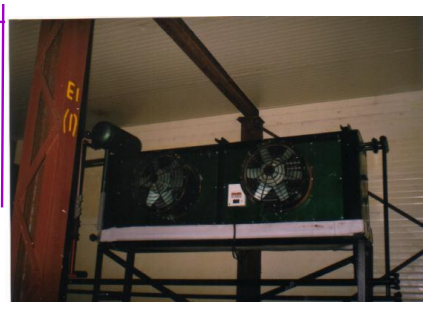
POTATO COLD STORAGE

PROPER UTILIZATION OF SPACE

MODERN COLD STORE FEATURES

CLEAN INTERIORS

MODERN COLD STORE FEATURES



PROPER AIR FLOW

MODERN COLD STORE FEATURES

CHILLED WATER INSULATED PIPES WITH PVC CLADDING

COLD STORAGE CONSTRUCTION

COLD STORE OVER EXISTING RCC BUILDING COLD STORES

2009

COLD STORAGE CONSTRUCTION

PEB & Panels over RCC Building

COLD STORAGE CONSTRUCTION

COLD STORAGE CONSTRUCTION

Long Height Corridor

COLD STORAGE CONSTRUCTION

Corridor & Multi Level Doors

COLD STORAGE CONSTRUCTION

Flooring

COLD STORAGE CONSTRUCTION

Ceiling Panels

COLD STORAGE CONSTRUCTION

Ceiling Panels

COLD STORAGE CONSTRUCTION

Chilled Water Piping

COLD STORAGE CONSTRUCTION

Chilled Water Pipe Support

COLD STORAGE CONSTRUCTION

Chilled Water Pipe Insulation

COLD STORAGE CONSTRUCTION

Chilled Water Pipe Insulation

COLD STORAGE CONSTRUCTION

PRE-INSULATED PIPE

MODERN COLD STORE CONSTRUCTION

Panel Erection Inside Warehouse

- Less labour intensive & fast construction technology.
- More interior space.

MODERN COLD STORE CONSTRUCTION

CLEAN ROOM

MODERN PRACTICES IN COLD STORE FEATURES

Food Processing

Chambers made from PUF Panels

MODERN PRACTICES IN COLD STORE FEATURES

Food Processing

Chambers made from PUF Panels

COLLECTION CENTRE STORES

- Small stores
- Prefab Panels
- 5-7 degree temperature drop
- With or without cooling
- Exhaust fan

Field Store

TRANSPORTATION

REFRIGERATED VAN

TRANSPORTATION

REFRIGERATED VAN

STRUCTURE – FRAMEWORK - PANELS

TRANSPORTATION

REFRIGERATED VAN

INSULATED DOORS

TRANSPORTATION

REFRIGERATED VAN

RUBBER GASKET SEALING

TRANSPORTATION

REFRIGERATED VAN STORES

RUBBER GASKET SEALING

TRANSPORTATION

PLASTIC CURTAIN

TRANSPORTATION

REFRIGERATED VAN

INTERIOR

COLD STORAGE CONSTRUCTION COST

I. CONVENTIONAL COLD STORE
CAPACITY : 5000 MT

a) Brick : 5 Lacs nos. @Rs.12/Brick
= Rs.60 Lacs

b) 4-6" EPS + 0.5 / 0.6mm TCT = Rs.60 Lacs
Colour coated GI Sheet

c) Total Cost : Rs. 10,000 – 12,000/MT

COLD STORAGE CONSTRUCTION COST

II. MODERN COLD STORE
CAPACITY : 5000 MT

a) Panels : Rs. 115-120 Lacs

b) Total Cost : Rs. 12,000 – 14,500/MT
(PEB, Panels, Refrigeration, Civil, Racking, machinery etc.)

III. Difference : 20-25 %

COLD STORAGE CONSTRUCTION COST

IV. Almost same for conversion from Brick + Insulation to panels i.e. Rs.120 Lacs

V. Total cost for 7000 tons Cold Store with RCC Roof, RCC columns & Panels = Rs.675 Lacs {@9643/ Ton (approx.)}

COLD STORAGE CONSTRUCTION COST

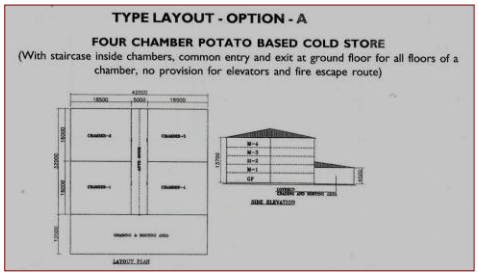
CAPACITY : 7000 MT
RCC Roof, RCC columns & Panels

Civil	:	250 Lacs
Panel	:	115 Lacs
Land	:	50 Lacs
Building	:	30 Lacs
Racking	:	50 Lacs
Lighting	:	80 Lacs
Machinery	:	100 Lacs
		675 Lacs

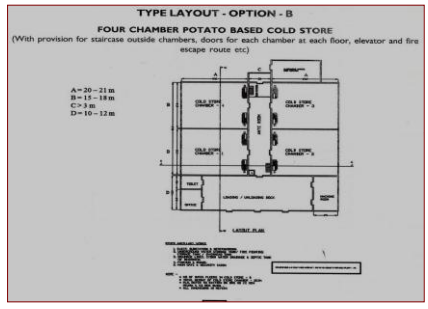
TECHNICAL STANDARDS AND PROTOCOL FOR THE COLD CHAIN IN INDIA

National Horticulture Board
(Department of Agriculture & Cooperation
Ministry of Agriculture, Govt. of India)
85, Institutional Area, Sector-18
Gurgaon -122015 (Haryana)

TYPICAL LAYOUT



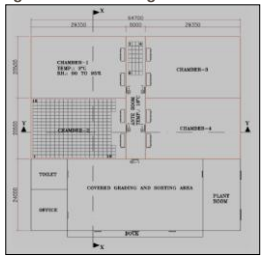
TYPICAL LAYOUT



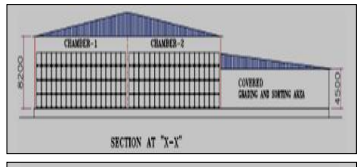
TYPICAL LAYOUT

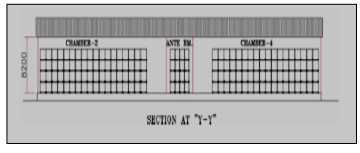
OPTION-1 :

Typical 5000 MT Multi Commodity Cold Store with provision of rapid room cooling and palletized storage, suitable for long / medium term storage of Fruit and Vegetables



TYPICAL LAYOUT

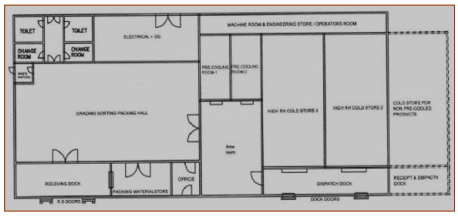




TYPICAL LAYOUT

OPTION-2 :

Typical Multi Commodity Cold Store with provision of separate pre-cooling rooms and high humidity cold stores



TYPICAL CONFIGURATION

- Cold Chamber : 250 -1250 MT – 4 nos.
- Multi Commodity chambers : 30-1250 MT
- Pre-cooling chamber : 30-150 MT

CONSTRUCTION FEATURES

Super Structure Foundation : As per BIS Standards

Cold Store Building : RCC OR steel structure / PEB as per IS : 875

Cold Chamber :

Walls -
1. 230mm brick wall with plaster on both sides, vapour barrier insulation and profiled pre-coated GS sheet
2. **Pre-fab steel structural frame work with insulated panel boards**

CONSTRUCTION FEATURES

Cold Chamber :

Roof -
1. RCC slab with waterproofing , proper sloping and mosaic finish.
2. Truss roof with pre-coated GS sheet with FRP sheet provision for natural lighting and turbo ventilators or alternatively insulated roofing panels. There should be provision for fixing insulated panels from the trusses to act as False Ceiling. FRP sheet for natural lighting

Floor - Base concrete with insulation & RCC finish.

CONSTRUCTION FEATURES

STEEL / PRE-ENGINEERED CONSTRUCTION

- Structure as per ASTM / BIS Standards
- Wall, Ceiling & partition with insulated panels of PUF, 1-1.2 mtr. Wide & length max. 12 mtr., 80mm thick.
- Single piece from floor to ceiling
- Held by fasteners
- Joints sealed with Silicon Sealant

CONSTRUCTION FEATURES

ANTE ROOM

- At least one Ante room
- Sorting, grading area
- Temperature range 20-24 deg.C
- Mechanized sorting, grading, washing & packing
- Palletization & Strapping Facility
- Pallet Jack & Fork Life
- Bins, Crates, Pallets and Racks
- Strip curtains for cold rooms and air curtains for external outlets / inlets
- Rodent proof civil structure and proper drainage of water to be ensured
- Rooms for machines, Electrical etc.

Insulation Thickness

Minimum Insulation Thickness based on Recommended U Values for -4 to +2^0 Cold Storage

Type of Insulation	Material		Wall		Ceiling / Roof U Value = 0.24 W/m^{2}K	Floor U Value = 0.29 W/m^{2}K
			External U Value = 0.27 W/m^{2}K	Partition U Value = 0.58 W/m^{2}K		
	p Density Kg/m3	K (at 10^{0}C) W/mK	Thickness mm	Thickness mm	Thickness mm	Thickness mm
EPS	15	0.036	150	75	150	125
PUF	32	0.023	100	50	100	100
XPS##	30-35	0.025	100	50	100	100
Phenolic Foam***	50	0.026	100	50	125	100
Mineralwool***	48	0.033	125	50	125	100
Bonded Fibre Glass / Glasswool ***	32	0.033	125	50	125	100
Panel	40±2	0.023	80	60	80	80

***Recommended only with vapour barrier and metal or FRP cladding min. 0.5mm TCT
##Recommended in conformance to ISO/FDIS 4898:2008(E) for properties of XPS used for thermal insulation of buildings, Categories-II, III & IV only.

CONSTRUCTION FEATURES

ANCILLARY MATERIALS

- Vapour barrier e.g. aluminium foil, polythene sheet, with bitumen / cold mastic adhesives
- Teakwood batten pegs, tees etc.
- G.S. Sheet runners (avoid wooden batten runners)
- Cladding of profiled / pre-coated G.S. Sheets 0.5 / 0.6mm thick / Fibre – glass sheets of suitable thickness

CONSTRUCTION FEATURES

FOR CONVENTIONAL INSULATION

WALL & CEILING

- Primer coat followed by two layers of bitumen
- Fixing aluminium foil min. 50 microns
- Fixing wooden pegs at suitable intervals
- Fixing two layers of insulation with staggered joints
- Fixing G.S. Sheet runners over the pegs in longitudinal & lateral directions
- Fixing profiled & pre-coated G.S. sheet 0.5 / 0.6mm thick over the runners with proper finishing of joints. Alternatively FRP sheets can be used

CONSTRUCTION FEATURES

FOR CONVENTIONAL INSULATION

FLOOR

- Laying of polythene sheet, min. 250 microns as vapour barrier
- Fixing insulation slabs in two layers with bitumen as adhesive for the first layer
- Covering with tar felt
- Laying PCC / tremix of 75mm / 100mm thickness.

CONSTRUCTION FEATURES

FOR INSULATED PANEL STRUCTURE

WALLS & CEILING

- Perimeter of the plinth to be in level for panel installation
- Panels to have cam lock or tongue & groove joints
- Sheet metal flashing to be provided on all concrete, curbing to be provided on wall – floor joints
- Horizontal tie bracings to be provided between vertical wall panels & external columns, to take care of wind loads
- Adequate numbers of pressure relief ports to be provided on all chambers with electrical connection
- Insulated doors shall be suitable for panel mounting

NHB OPERATIONAL GUIDELINES

CAPITAL SUBSIDY FOR NEW CONSTRUCTION / EXPANSION/ MODERNIZATION OF COLD STORAGES

Components : Cold Stores, CA, MA, Pre-cooling Units
Capacity : Up to 5000 MT
Amount : 40% of capital project cost in general areas
55% in case of Hilly & scheduled areas

For Storage capacity of 5000 MT

NHB OPERATIONAL GUIDELINES

GENERAL CONDITION

1. Multi Chamber Cold Storages with Mezzanine floors of RCC or wooden structure, without precooling, 0-16^{0}C or above, RH 80-95%, 65-70% for Onion & Garlic, min. 2 chambers, standard insulation, cooling system, safety devices.

Construction cost basis
Rs. 6000 per MT

NHB OPERATIONAL GUIDELINES

GENERAL CONDITION

2. Multi Chambered & Multi Product Cold Storage, without precooling system, -2 to 16^{0}C, RH 80-95% general F&V, 65-70% for Onion & Garlic, energy saving devices, heat exchanger with CO_2 control, control of micro organism, mechanical handling – fork lifts, safety devices.

a) Civil / Prefab engg. structure, insulation, cooling as per standards excluding mezzanine
Construction cost basis
Rs. 7000 per MT

b) Civil / prefab engg. structure, insulation, cooling as per standards excluding mezzanine, having pack house facilities (sorting, grading, wax in, packing)
Construction cost basis
Rs. 8000 per MT

NHB OPERATIONAL GUIDELINES

GENERAL CONDITION

3. Modernization of Cold Stores
   a) Upgradation of Thermal Insulation
   b) Upgradation of cooling system, safety devices, electricals

Rs.1000/MT for Multi chambered Cold Stores with mezzanine floor

Rs.2000/MT for Multi chambered multi product with prefab engg. and with or without pack house

NHB OPERATIONAL GUIDELINES

GENERAL CONDITION

4. CA Storages : Rs.32000/MT (cost basis)
5. Should meet NHB Standard norms
6. In case of varying technical specifications a committee will decide

THERMAL INSULATION

Procedure - As per IS : 661

Materials :

a) Expanded Polystyrene
b) Rigid Polyurethane Foam
c) Rigid Phenolic Foam
d) Mineralwool / Glasswool
e) Extruded Polystyrene

Thermal Insulation for Refrigerated Piping :
EPS, PUF, Nitrile Rubber

THERMAL INSULATION

Vapour Barrier : Aluminium Foil, Polythene Sheet

Bitumen Cold Adhesive Mastic for insulated panel structure.

Pre-fabricated panels with cam lock or Tongue & Groove joints.

IS : 661

Thermal Insulation of Cold Storage – Code of Practice

(4th Revision of IS : 661))

(ICS No.27.220; 91.120.10)

IS : 661

THERMAL INSULATION MATERIALS

- Expanded Polystyrene
- Polyurethane / Polyisocyanurate Foam
- Fibrous material
- Polyurethane sandwich Panels

IS : 661

IMPORTANT CHARACTERISTIC OF A COLD STORAGE INSUALTION

a) Low Thermal Conductivity (K)
b) Lower Thermal Diffusivity (d)
c) High Thermal Resistivity (R)
d) Stability at low temperature

IS : 661

IN-SITU APPLICATION

Insulation of Concrete / Masonry Walls finished with Plaster.

- Cleaning of the surface
- Application of primer and vapour barrier layer
- Fixing of wooden batten and 40mm wide and equal to insulation thickness suitably placed,
- Providing insulation in multi layer (single layer 50mm with joints staggered)
- Application of wire netting and fixed with galvanized U nails
- Application of cement plaster
- Floor insulation shall be with bituminous water proofing, insulation slab, bituminous kraft paper and concrete.

IS : 661

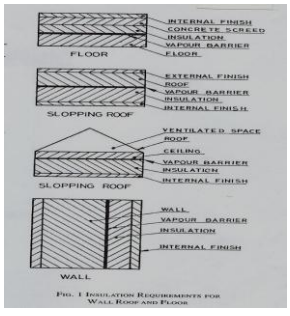


FIG. 1 INSULATION REQUIREMENTS FOR WALL ROOF AND FLOOR

Additional vapour barrier on inner side may also be used

IS : 661

Insulated doors comprising of well designed frames, hinges, seals ad locking devices.

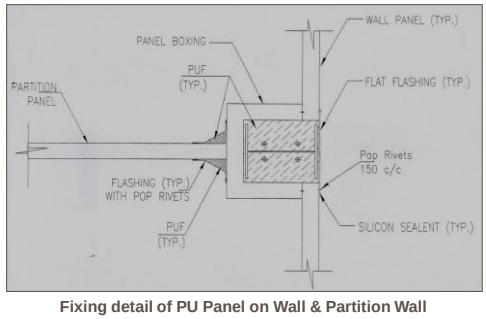
Doors made from PU panels complete with all fixtures.

IS : 661

PANEL APPLICATION

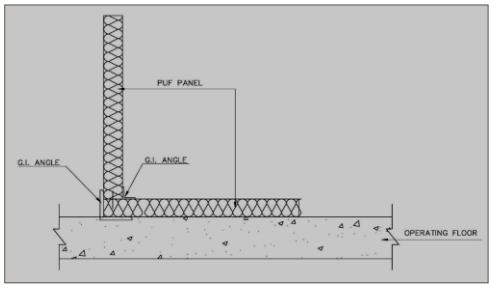
- Main structure of Steel / RCC frame or Brick
- PU Panels are directly mechanically fastened to the Steel or RCC structure frame
- Incase of brick wall, one side paper laminated panels to be mechanically fastened.
- Panel joints sealed with silicon sealant.
- Floor insulation with PUF slabs.
- Ceiling insulation – PU Panel shall be placed on insulated T-beams hung from trusses.

IS : 661



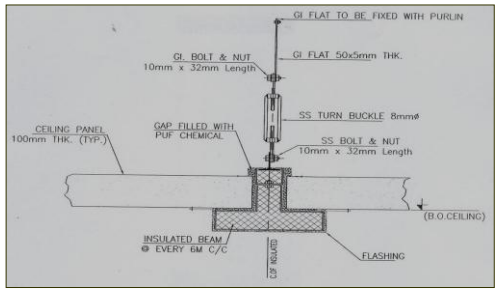
Fixing detail of PU Panel on Wall & Partition Wall

IS : 661



Fixing detail of PU Panel on Floor

IS : 661



Fixing detail of PU Panel on Ceiling

IS : 661

Physical Properties of Insulating Materials

Sl. No. (1)	Characteristics (2)	Rigid Polyisocyanurate Foam (PIR) (3)	Rigid Polyurethane Foam (PUF) (4)	Rigid Phenolic Foam (5)	Expanded Polystyrene (EPS) (6)	Bonded Rockwool (7)	Bonded Glasswool (8)
i)	Relevant IS Code	IS : 12436	IS : 12436	IS : 13204	IS : 4671	IS : 8183	IS : 8183
ii)	Useful forms	Slabs & pipe sections	Slabs & pipe sections	Slabs & pipe sections	Slabs & pipe sections	Slabs & pipe sections	Slabs & pipe sections
iii)	Density, kg/m3	30-38	34-38	32-60	15-35	Slab – 48 P/S – 144	Slab – 32 P/S – 80
iv)	Thermal Conductivity at 10°C, W/mK	0.023 at 32 kg/m3	0.023 at 36 kg/m3	0.026 at 50 kg/m3	0.037 at 15 kg/m3	0.033 at 48 kg/m3	0.033 at 32 kg/m3
v)	Thermal diffusivity, m²h	0.0018-0.0024	0.0018-0.0024	0.0016-0.0029	0.0037-0.0078	0.0006-0.0018	0.0011-0.0027
vi)	Water vapour transmission rate, ng/Pa.sm. Max.	5.5	5.5	5.5	7.95	-	-
vii)	Water absorption after 24 h immersion, percent by mass	0.1	0.1	0.1	1.0	2.3	2.3

IS : 661

ANNEX B

ANNEX B (1)

(Clause 4.2.1)

THICKNESS OF INSULATION (MM) FOR DIFFERENT STORAGE TEMPERATURES WITH DESIGN AMBIENT TEMPERATURE OF 35-45°C AND 70-90 PERCENT RELATIVE HUMIDITY

THICKNESS FOR EXPOSED WALL

Storage Temp. Range	Insulation thickness For different materials (in mm) (Calculation as per IS-3792)					
(DegC)	PUF/PIR	Phenolic foam	EPS	Rock wool	Glass wool	PUF/PIR Panel
-30 to -20	120	140	200	180	180	130
-20 to -15	100	110	160	150	150	100
-15 to -4	90	100	150	130	130	90
-4 to +2	80	90	120	110	110	80
+ 2 to 10	60	60	90	80	80	60
10 to 16	40	50	70	60	60	50
16 and above	10*	10*	10*	10*	10*	10*

IS : 661

THICKNESS FOR INTERMEDIATE WALL

Storage Temp. Range	Insulation thickness For different materials (in mm) (Calculation as per IS-3792)					
(Deg C)	PUF/PIR	Phenolic foam	EPS	Rock wool	Glass wool	PUF/PIR Panel
-30 to -20	50	50	70	60	60	50
-20 to -15	50	50	70	60	60	50
-15 to -4	50	50	70	60	60	50
-4 to +2	40	40	60	50	50	40
+ 2 to 10	20	20	30	30	30	20*
10 to 16	20	20	30	30	30	20*
16 and above	10*	10*	20*	20*	20*	10*

IS : 661

THICKNESS FOR ROOF

Storage Temp. Range	Insulation thickness For different materials (in mm) (Calculation as per IS-3792)					
(Deg C)	PUF/PIR	Phenolic foam	EPS	Rock wool	Glass wool	PUF/PIR Panel
-30 to -20	160	180	260	230	230	160
-20 to -15	130	140	210	190	190	130
-15 to -4	110	120	170	150	150	100
-4 to +2	90	100	150	130	130	90
+ 2 to 10	80	90	120	110	110	80
10 to 16	80	90	120	110	110	80
16 and above	20*	20*	30	30	30	20*

IS : 661

THICKNESS FOR FLOOR

Storage Temp. Range	Insulation thickness For different materials (in mm) (Calculation as per IS-3792)					
(Deg C)	PUF/PIR	Phenolic foam	EPS	Rock wool	Glass wool	PUF/PIR Panel
-30 to -20	110	130	180	160	160	110
-20 to -15	100	110	150	140	140	100
-15 to -4	80	90	130	120	120	80
-4 to +2	80	90	120	110	110	80
+ 2 to 10	50	50	70	60	60	50
10 to 16	30	40	50	50	50	30
16 and above	10*	10*	20*	20*	20*	10*

IS : 661

ANNEX B (2)
(Clause 4.2.1)
Thermal & Load Characteristics of PU Panels

Thickness	mm	60	80	100	120	150	200
U Values	W/m²C	0.36	0.26	0.21	0.19	0.14	0.11
Panel Weight	Kg/m²	11.25	12.05	12.85	13.65	14.85	16.85

IS : 661

Recommended "R & U" Value for cold storage structure

Storage Temp. Range (DegC)	Maximum "R" Value (m2k/w) , "U" Value (w/m2k)							
	Exposed walls		Intermediate walls		Roofs		Floors	
	R	U	R	U	R	U	R	U
-30 to -20	5.88	0.17	2.12	0.47	7.14	0.14	5.00	0.20
-20 to -15	4.76	0.21	2.12	0.47	5.88	0.17	4.34	0.23
-15 to -4	4.34	0.23	2.12	0.47	4.76	0.21	3.70	0.27
-4 to +2	3.70	0.27	1.72	0.58	4.16	0.24	3.44	0.29
+ 2 to 10	2.85	0.35	1.07	0.93	3.44	0.29	2.12	0.47
10 to 16	2.12	0.47	1.07	0.93	3.44	0.29	1.56	0.64
16 and above	0.78	1.28	0.68	1.47	0.95	1.05	0.61	1.63

IS : 661

ANNEXURE - 'D'

ENERGY CONSERVATION CASE FOR BUILDING

COMPOSITE CASE STUDY FOR - EXPOSED WALL

Design Condition
Insulation Material
Plaster both side - 12mm
Brick wall - 225 mm

CASE

Considering for 1 m2 Wall

Insulation material	Heat gain through wall (W/m2)	Savings (W/m2)	Total Heat ingress	Cost of Energy @ Rs.5.10/KW For 365 Days ,24 Hr.	Energy Savings (at 70% efficiency)	Cost of insulation Material	Savings	Pay back period	R-value
	A	B	(KW)	(Rs/Year)	(Rs/Year)	(Rs.)	(Rs./Yr.)	Months	(m2- °C / W)
Brick Wall	149.6	-	0.150	6864	NIL	0.00	NIL	-	R-0.467
100 mm PUF/PIR Insulation	12.31	137.29	0.0123	543	4299	1100	3199	4.13	R-8.88
160 mm Rockwool Insulation	11.81	137.79	0.0118	520	4314	800	3514	2.73	R-8.92
160 mm Glasswool Insulation	11.81	137.79	0.0118	520	4314	900	3414	3.16	R-8.92
140 mm Phenolic Foam	11.09	138.51	0.011	491	4336	1400	2836	5.72	R-8.68
120mm PUF Panel *	12.31	137.29	0.0123	543	4299	1800	2499	8.64	R-8.88

* PUF Panel is indigenous manufacturing but not in IS

MODERN PRACTICES IN COLD STORE CONSTRUCTION

CASE STUDY (For Potato Storage)
CONVENTIONAL COLD STORAGE DESIGN
Vs.
MODERN COLD STORAGE DESIGN

Storage Capacity : 6000 MT
Size : 105' (32M) x 105'(32M) x 60'(18M) (H)

MODERN PRACTICES IN COLD STORE CONSTRUCTION

CONVENTIONAL STORAGE

Wall Design :

Brick Wall : 225mm (9")
Cement Plaster : 12 mm (both sides), Bituminous primer.
Al-Foil (vapor barrier) : 0.05mm.
(U-nails and Wooden Runners and Battens for fixing Insulation)
Expanded Polystyrene : 100mm or 4" (in two layers).
The final finish is a rendering of plaster ½" or 12mm.
Total Wall Thickness : 360 mm.

MODERN PRACTICES IN COLD STORE CONSTRUCTION

CONVENTIONAL STORAGE

Ceiling Design

Ceiling is made up in a similar manner, with EPS being 100 mm or 4" in thickness (in case of RCC Slab as roof).

Floor Design

Floor is insulated with 60mm EPS, after tar felting and finished with Lean Concrete (PCC) 3" (75mm).

MODERN PRACTICES IN COLD STORE CONSTRUCTION

THEORETICAL HEAT GAIN FOR CONVENTIONAL CONSTRUCTION

Considering the Thermal Conductivity value for Polystyrene Foam (EPS) as 0.036 W/mK in order to allow for aging and imperfections during application for an ambient of 40-45 deg.C and operation at 4 to 6 deg.C.

MODERN PRACTICES IN COLD STORE CONSTRUCTION

CONVENTIONAL STORAGE

Thermal Transmission Values

Q Wall = 12.26 W/m2

Q Ceiling = 8.98 W/m2

Considering a 6000MT Potato Cold Store

Dimension 105' (32M) x 105'(32M) x 60'(18M) (H)

Total Area

Wall – 1152 m2, Ceiling -1024m2, Floor – 1024 m2.

Thermal Transmission Value

Q Total (Theoretical) = 24 KW

MODERN PRACTICES IN COLD STORE CONSTRUCTION

MODERN COLD STORES

Wall = 80mm PUF Panel

Ceiling = 100mm PUF Panel

Floor = 60mm EPS Slabs
finished with lean concrete

MODERN PRACTICES IN COLD STORE CONSTRUCTION

MODERN COLD STORAGE – PUF Panel 80 / 100mm

Thermal Transmission Values

Q Wall = 11.00 W/m2

Q Ceiling = 8. 57 W/m2

Q Total = 21 KW

12-15% reduction in heat gain.

Initially Energy Savings Rs.13000 per month or Rs.1.60 Lacs per annum.

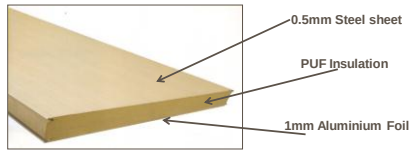
Thereafter Rs.43000 per month or Rs.5-6 Lacs per annum.

EXISTING COLD STORES

- Civil Structure / Building Sound Construction
- Insulation damaged
- Reap of Insulation

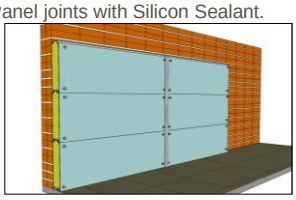
REVAMP PROCEDURE

- Insulation can be replaced by –
  Pre-fab Polyurethane Panels



EXISTING COLD STORES

- Removal of old insulation & plastering of surface.
- Prefab Polyurethane Panels with facing side metal finish and inner side paper or Aluminium foil finish.
- Panels to be directly fixed to the walls with self drilling fasteners.
- Sealing of Panel joints with Silicon Sealant.



REVAMPING OF EXISTING STORES

Replacement of moisture soaked Insulation

- **Fixing prefab panels with one side metal facing and paper facing on the walls.**

CHATRAKARAN POTATO COLD STORAGE, INDORE (MP)

FIRST MODERN POTATO COLD STORE 1997

SANGHA CHAITANYA COLD STORAGE, KHAMMAM (AP)

NEETHI COLD STORAGE, HYDERABAD

SAFAL COLD STORAGE COMPLEX, BANGALORE

HINDUSTAN AGRO COOPERATION LTD.

Agro Irradiation Cold Storage at Rahuri, Ahmednagar

25000 MT

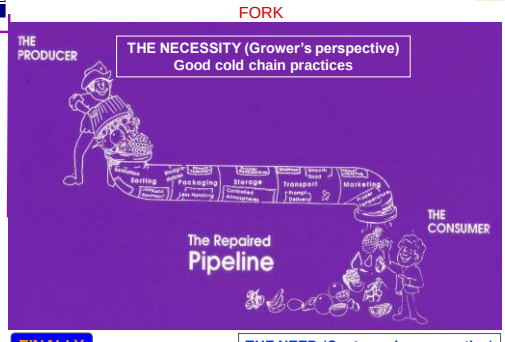
PRAGATI COLD STORAGE, KUNDLI

2010

MODERN COLD STORE

Future Trend for Construction

MODERN COLD CHAIN MANAGEMENT INCREASING LIFE SPAN OF FRESH PRODUCE FROM FARM TO FORK



FINALLY

THE NEED (Customer's perspective)
Fresh & Safe Produce

Pay heed to the calls, before another moment falls

Everyone thinks of changing the world, but no one thinks of changing himself.

Leo Tolstoy

PRESENTER

GRIHA

ENERGY IS LIFE
CONSERVE IT
ESCO

SAVE ENERGY, SAVE EARTH

LLOYD INSULATIONS (INDIA) LIMITED


THANK YOU !!