8 Gormley
11/6/12

Leaving Certificate Examination 2012

The Construction and Design of a Slatted Shed.

Exam No. : 150932

Acknowledgements:

- I'd like to thank The Department of Agriculture and Food for a copy of their report on "S.101: The Minimum Specifications for the Structure of Agricultural Buildings. It gave me a great insight into the various recommendations and restrictions associated with constructing a Slatted Shed efficiently, safely and legally.

- I'd also like to thank M.F. Kelly & Associates, Mullingar, Co. Westmeath for the package they sent me containing plans of various types of slatted houses. Those plans helped me choose which type of slatted house to do my report on.

- I'd like to thank Seamus Murray, Allegesh, Scotstown, Co. Monaghan, a local farmer, for allowing me to look at his newly built slatted house and for the permission to photocopy the plans of his slatted house.

Table of Contents

Chapter 1: Project Outline

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Description of Project

I'm doing a project on the construction and design of a 4 bay, single-sided slatted shed suitable for the housing of cattle during the winter months. The Slatted Shed is a vital part of the modern farm because nobody fancies shovelling dung out of a solid floored cattle shed. The slats are beneficial for the farmer, since it eases the workload, and the cattle, since it's more hygienic. It'll be 16300 x 19050mm in area and 6333mm in height, so my model of the shed will be on a scale of 1:25.

Why I chose this project

I chose this project because I live in a rural community where farming is the main occupation. I drive past these sheds every day and work in them many days too but I never really understood how it was built. I thought it would be a great learning experience to base my project on the shed.

Background of the Project

People have farmed livestock ever since the iron age and ever since, mankind has tried to improve their methods of farming to raise the quality of animal and also to reduce the amount of work needed to take care of them. The design of cattle sheds have improved vastly over the years. Only 200 years ago in Ireland, animals were stored in a byre inside the dwelling. The cattle lived in a room below and the people lived upstairs. The heat of the cattle rose into the living space. This essentially was an early form of under-floor heating. To improve health and hygiene, separate sheds were built to store the cattle in the winter months. These sheds were originally built with a solid floor that may have consisted of soil and dirt. It used to be that silage, hay and water needed to be brought in by hand and dung needed to be shovelled out of pens twice a day. This amount of hard work prevented the farmer from owning too many cattle without hiring in extra help.

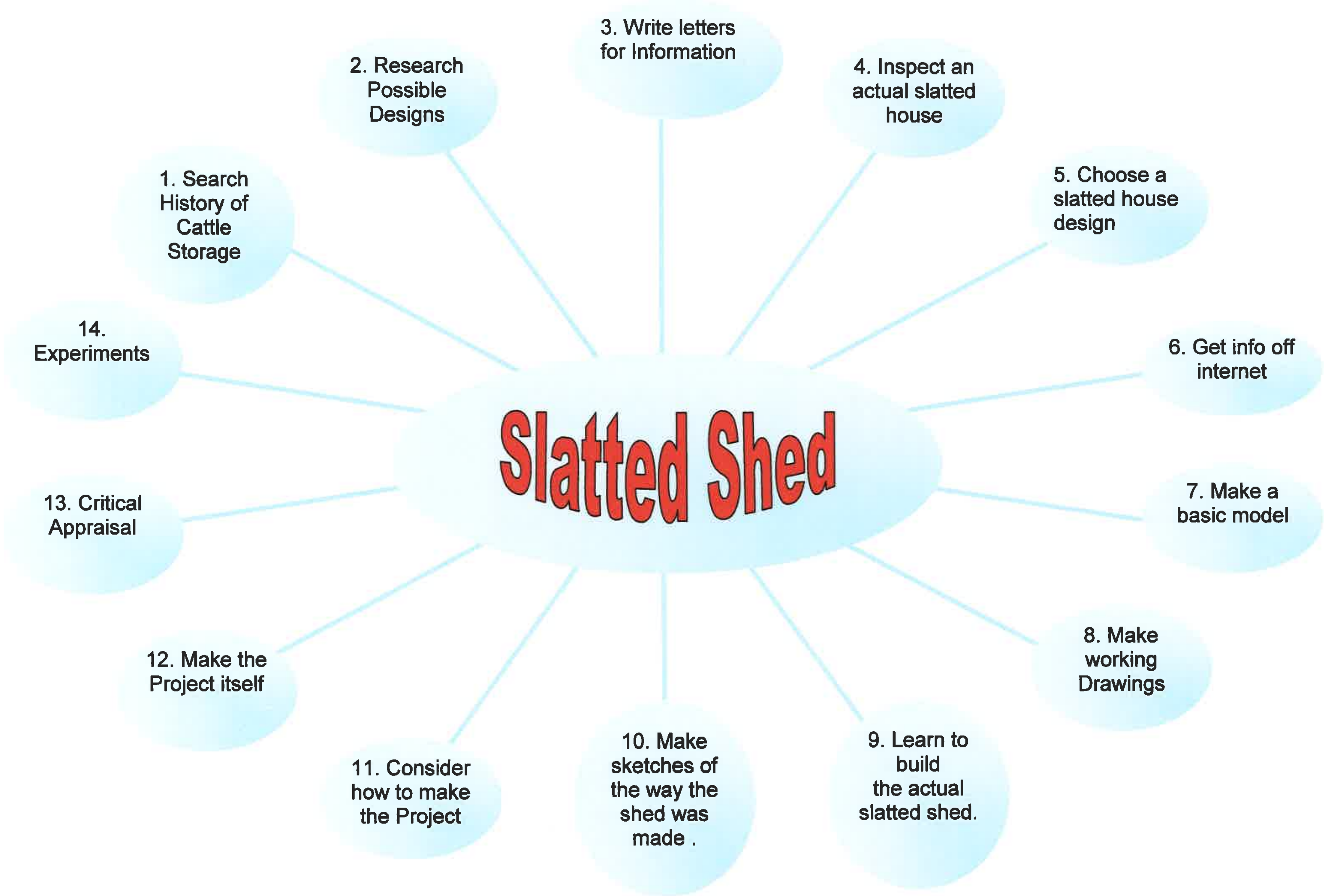
The modern slatted house offers a great reprieve from all this monotonous work. An underground tank stores all the dung from the winter months, ready to be used as fertilizer during the warmer months. A passageway down the centre of the shed allows a tractor or its equivalent to bring in silage. Barriers prevent cattle from tramping and dunging on fresh silage so very little food is wasted. Water is provided in drinkers with a ball float so you need not worry about carrying buckets of water to the cattle, unless of course the water freezes in the pipes during extremely cold weather.

The slatted shed has become very popular due to all these advantages. The introduction of the grant for slatted houses made these sheds very common. Nearly all farmers have at least one nowadays. They are not complicated in design and materials consist of your basic blocks mortar, RSJs, galvanised iron, precast slats, slabs and concrete.

The construction of slatted houses has dropped considerably due to:

(a) The removal of the grant scheme,
(b) Lower wages for dairy production,
(c) Importation of produce from different countries and
(d) The general lack of money experienced by all during the recession.

However, I still believe that this was a good choice of project because it is part of our heritage and that there will always be agriculture in Ireland, and where there's agriculture, there's a demand for the construction of farm buildings.


Slatted Shed
1. Search History of Cattle Storage
2. Research Possible Designs
3. Write letters for Information
4. Inspect an actual slatted house
5. Choose a slatted house design
6. Get info off internet
7. Make a basic model
8. Make working Drawings
9. Learn to build the actual slatted shed.
10. Make sketches of the way the shed was made .
11. Consider how to make the Project
12. Make the Project itself
13. Critical Appraisal
14. Experiments

Chapter 2: Research and Investigation

Methods of Research

I carried out research on my project through the following methods:

- ***Writing letters to companies-*** *I wrote letters to these companies:*

MF Kelly & Associates	Leonard Engineering	Seamus Murray
104 Greenpark Meadows	Old Tannery	Allegesh
Mullingar	Coolshannagh	Scotstown
Co. Westmeath	Co. Monaghan	Co. Monaghan

- ***Internet Research-*** *I searched the following websites for information:*

www.mfKelly.ie-	Makes plans for Slatted Sheds
www.google.ie-	Search engine, can be used to find other websites
www.ict.mic.ul.ie-	Construction company who specialize in Slatted Houses
www.agriculture.gov.ie-	Department of Agriculture and Food

- ***Site visit-*** I visited the construction site where my neighbour was building a 4-bay slatted house several times during the course of its construction. I learned that the regulations are just guidelines, and that to build a high quality slatted house, you mustn't simply follow the minimum specifications, but build a stronger structure than is needed.

Site Visit

1. Here we see the excavated sit for the tank and the concrete lorry ready to pour the floor of the tank.

2. Here we see the builders using a pump to drain the rainwater from the pit for the tank before pouring the concrete

3. The reinforcement iron shown here is used to strengthen the floor of the tank.

4. Here we see the builders smoothing out the poured floor of the tank. The reinforcement iron seen is used to support the poured walls.

5. Here we can see the completed tank to the left and the walk which has yet to be poured with 125mm of concrete.

6. Here we see the completed rafters and stanchions. We can see the brackets on the second rafter used to support the purlins. We can also see the cross bracing used in the bay closest the door over the tank

7. Here we see the timbers used to support the side cladding and how they're fastened. We also see the purlins in place.

8. Here we see the position of the drinker and how the gates are arranged around it. The diagonal bars of the gate are designed to stop cattle barging into each other whilst feeding and to prevent calves breaking out of the pen.

9. Here we see the frame of the sliding door as well as it's slide-ways.

Sample Plan 1

MF Kelly & Associates

M.F. Kelly & Associates
ENGINEERING & PLANNING CONSULTANTS

104 Greenpark Meadows, Mullingar, Co. Westmeath
Telephone: 044 9333740 **Fax:** 044 9333740 **Mobile:** 085 7255182
Email: info@mfkelly.ie **Website:** www.mfkelly.ie

Daniel Murray
Beech Hill College
Dublin Road
Co. Monaghan

17 February 2011

Re: Slatted Shed Details.

Dear Daniel,

Please find attached two different types of Slatted Shed drawings for your construction project.

If you require any further information, do not hesitate to contact us.

Yours sincerely

Martin Kelly Eng. Tech. IEI

Martin Kelly Eng. Tech. IEI
M. F. Kelly & Associates

We Provide: Planning Applications, Extension Plans, House Plans, Percolation tests, Construction Supervision, Conservatory Plans, Map Certs.

LEONARD

Leonard Engineering (Monaghan) Ltd.

• Structural Steel Engineering • General Engineering •

28/02/2011

Daniel Murray
Beech Hill College,
Dublin Road,
Monaghan,
Co Monaghan.

Dear Daniel,
In reply to your letter regarding your project on Slatted Sheds we do not manufacture agricultural Structural Steel, we supply only Steel for Industrial & Commercial Projects and therefore We would not hold any information on Slatted Sheds.

If we can be of any other help to you or if you would like to visit our workshop in relation to Your project, then you are most welcome.

We wish you luck with the project.

Yours Faithfully

Martin Leonard
LEONARD ENGINEERING (MONAGHAN) LTD

Old Tannery, Coolshannagh, Monaghan, Co. Monaghan. Tel: (047) 81092 • Fax: (047) 84313


Portal Frame building, 30ft wide, steel structure


Built2last canopy bracket

ict.mic.ul.ie **Construction of a Slatted House**

NATIONAL DEVELOPMENT PLAN

DEPARTMENT OF AGRICULTURE AND FOOD

S. 101 **March 2006**

MINIMUM SPECIFICATIONS FOR THE STRUCTURE OF AGRICULTURAL BUILDINGS

I used these regulations to help me design my own slatted house. It has proved very useful for finding material sizes and researching the different construction elements that are used in the slatted shed. I have of course thinned this booklet down so that it contains only information relevant to my topic.

THE DEPARTMENT OF AGRICULTURE & FOOD
AN ROINN TALMHAÍOCHTA AGUS BIA

Barry's Introduction to Construction of Buildings.

3 Groundwork and Foundations

The foundation of a building is that part of walls, piers and columns in direct contact with, and transmitting loads to, the ground. The building foundation is sometimes referred to as the artificial foundation, and the ground on which it bears as the natural foundation. Early buildings were founded on rock or firm ground; it was not until the beginning of the twentieth century that concrete was increasingly used as a foundation base for walls. With the introduction of local and then national building regulations, standard forms of concrete foundations have become accepted practice in the UK, along with more rigorous investigation of the nature and bearing capacity of soils and bedrock.

3.1 Functional requirements

The primary functional requirement of a foundation is strength and stability.

Strength and stability

The combined, dead, imposed and wind loads on a building must be transmitted to the ground safely, without causing deflection or deformation of the building or movement of the ground that would impair the stability of the building and/or neighbouring structures. Foundations should also be designed and constructed to resist any movements of the subsoil.

Foundations should be designed so that any settlement is both limited and uniform under the whole of the building. Some settlement of a building on a soil foundation is inevitable. As the building is erected the loads placed on the foundation increase and the soil is compressed. This settlement should be limited to avoid damage to service pipes and drains connected to the building. Bearing capacities for various rocks and soils are assumed and these capacities should not be exceeded in the design of the foundation to limit settlement.

3.2 Bedrock and soil types

Ground is the general term for the Earth's surface, which varies in composition within the two main groups: rocks and soils. Rocks include hard, strongly cemented deposits such as granite, and soils the loose un-cemented deposits such as clay. Rocks suffer negligible compression and soils measurable compression under the imposed load of a building. The size and depth of a foundation is

One negative effect of this standardised approach is that some foundations may be over-designed for the loads they carry, either to avoid any possibility of foundation failure or simply through the application of inappropriate foundations for a particular building type. For example, it is not uncommon for timber-framed buildings to be built off foundations designed for heavier loadbearing masonry construction, essentially a lack of thought resulting in wasted materials and unnecessary expense.

There are a number of familiar approaches to foundation construction, from strip foundations, piles and rafts as described below (Figure 3.3), all of which are constructed of concrete.

Concrete

Concrete is the name given to a mixture of particles of sand and gravel, the aggregate, bound together with cement, the matrix. Fine aggregate is natural sand, which has been washed and sieved to remove particles larger than 5 mm, and coarse aggregate is gravel that has been crushed, washed and sieved so that the particles vary from 5 mm up to 50 mm in size. The fine and coarse aggregate are delivered separately. By combining them in the correct proportions, a concrete with very few voids or spaces in it can be made that produces a strong concrete.

The cement most used is ordinary Portland cement. It is manufactured by heating a mixture of finely powdered clay and limestone with water to a temperature of about 1200°C, at which the lime and clay fuse to form a clinker. This clinker is ground with the addition of a little gypsum to a fine powder of cement. Cement powder reacts with water and its composition gradually changes; the particles of cement bind together and adhere strongly to materials with which they are mixed. Cement hardens gradually after it is mixed with water. Some thirty minutes to an hour after mixing with water the cement is no longer plastic and it is said that the initial set has occurred. About 10 hours after mixing with water, the cement has solidified and it increasingly hardens to a dense solid mass after 7 days.

Water–cement ratio

The materials used for making concrete are mixed with water for two reasons: first to cause the reaction between cement and water, which results in the cement acting as a binding agent and, secondly, to make the material sufficiently plastic to be easily placed in position. The ratio of water to cement used in concrete affects its ultimate strength. If too little water is used the concrete is so stiff that it cannot be compacted and if too much water is used the concrete does not develop full strength. Very little water is required to ensure that a full chemical reaction takes place within the concrete mix. Any excess water will not be used and will leave very small voids within the concrete when the unused water eventually evaporates away. The water added must be sufficient to

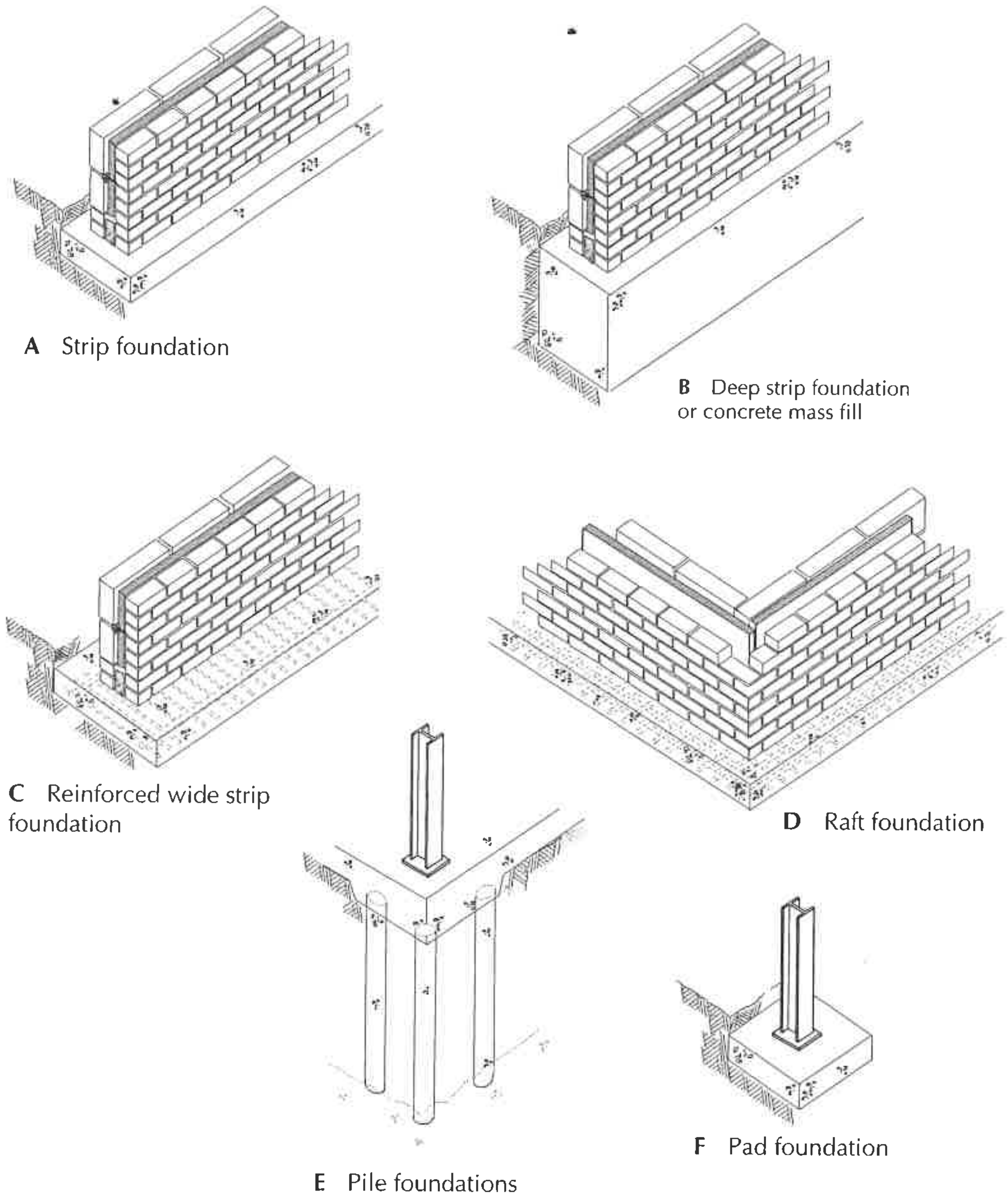


Figure 3.3 Foundation types.

allow the chemical reaction to take place and enable the concrete to be worked (poured or vibrated) into place. The amount of water required to make concrete sufficiently plastic (workable) depends on the position in which the concrete is to be placed. Plasticisers are added to the concrete mixture and enable the concrete to be more workable and fluid without increasing the quantities of

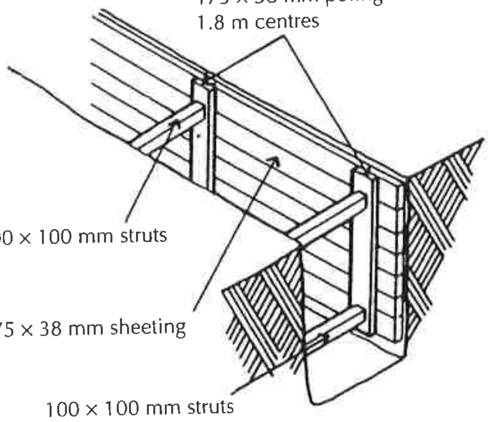
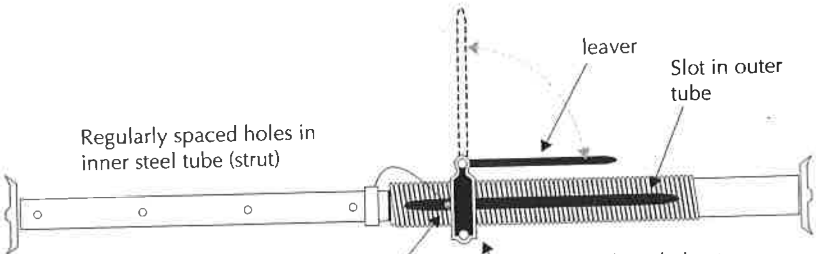


Figure 3.38 Struts, poling boards and sheeting.

Where the soil is soft, such as soft clay or sand, it will be necessary to use more closely spaced poling boards to prevent the sides of the trench between the struts from falling in. To support the poling boards horizontal walings are strutted across the trench, as illustrated in Figure 3.37.



Standard sizes of strut available

Extension in metres

Closed	**Open**
0.495	0.737
0.705	1.137
1.029	1.740

Figure 3.39 Adjustable steel strut.

water used. Using plasticisers keeps the strength of the concrete high without increasing the quantity of cement.

Concrete mixes

The materials used in reinforced concrete are commonly weighed and mixed in large concrete mixers. It is not economical for builders to employ expensive concrete mixing machinery for small buildings and the concrete for foundations, floors and lintels is usually delivered to site ready mixed, except for small batches that are mixed by hand or in a portable mixer.

British Standard 5328: specifying concrete, including ready-mixed concrete, gives a range of mixes. One range of concrete mixes in the Standard, ordinary prescribed mixes, is suited to general building work such as foundations and floors. These prescribed mixes should be used in place of the traditional nominal volume mixes such as 1:3:6 cement, fine and coarse aggregate by volume, which have been used in the past. The prescribed mixes, specified by dry weight of aggregate, used with 100 kg of cement, provide a more accurate method of measuring the proportion of cement to aggregate and, as they are measured against the dry weight of aggregate, allow for close control of the water content and therefore the strength of the concrete.

Prescribed mixes are designated by the letters and numbers C7.5P, C10P, C15P, C20P, C25P and C30P; the letter C stands for 'compressive', the letter P for 'prescribed' and the number indicates the 28-day characteristic cube crushing strength in newtons per square millimetre (N/mm^2) that the concrete is expected to attain. The prescribed mix specifies the proportions of the mix to give an indication of the strength of the concrete sufficient for most building purposes, other than designed reinforced concrete work.

Table 3.1 equates the old nominal volumetric mixes of cement and aggregate with the prescribed mixes and indicates the uses for these mixes.

Ready-mixed concrete

Ready-mixed concrete plants are common and are able to supply to all but the most isolated building sites. These plants prepare carefully controlled concrete mixes, which are delivered to site by lorries on which the concrete is churned to

Table 3.1 Concrete mixes

Nominal volume mix	BS 5328 Standard mixes	Uses
1:8 all-in 1:3:6	ST1	Foundations
1:3:6 1:2:4	ST2 ST3	Site concrete
1:1½:3	ST4	Site concrete reinforced

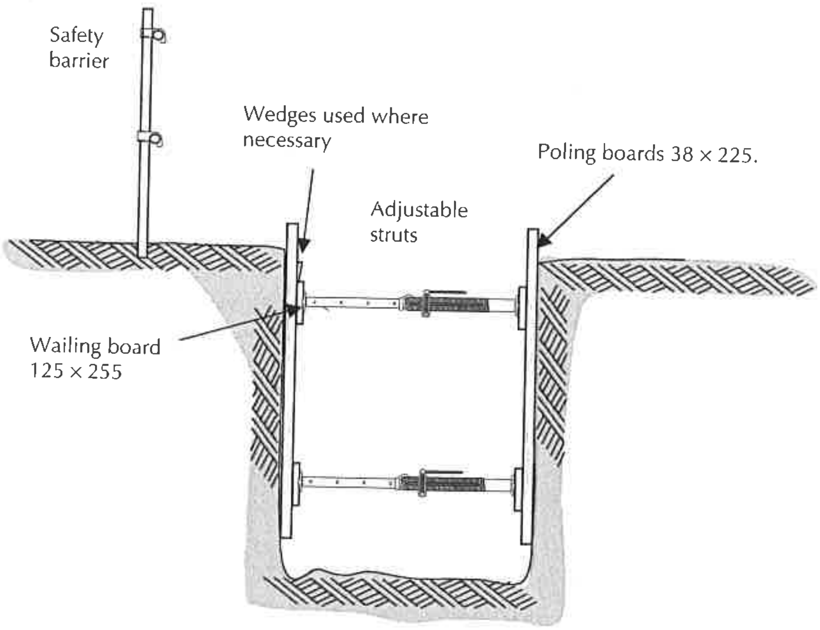


Figure 3.40 Open or closed timbering using adjustable steel strut.

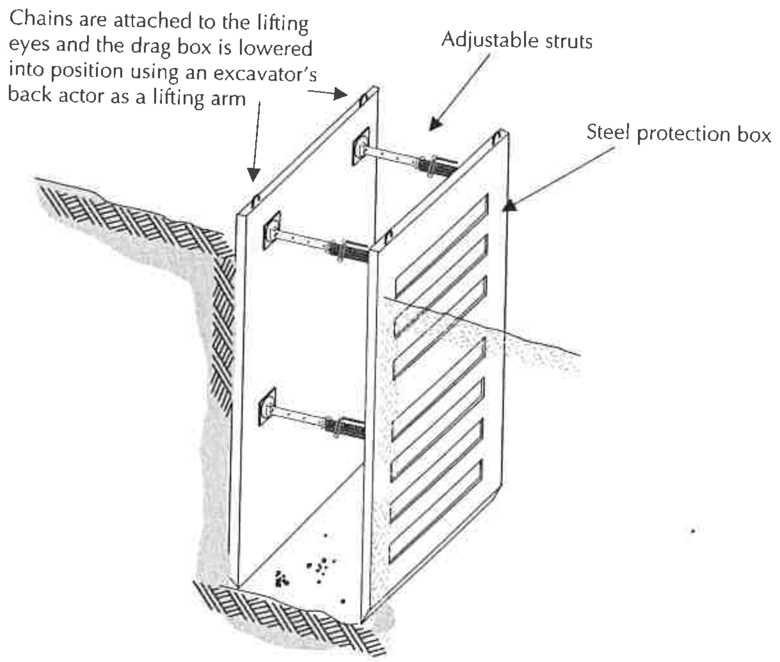


Figure 3.41 Trench box.

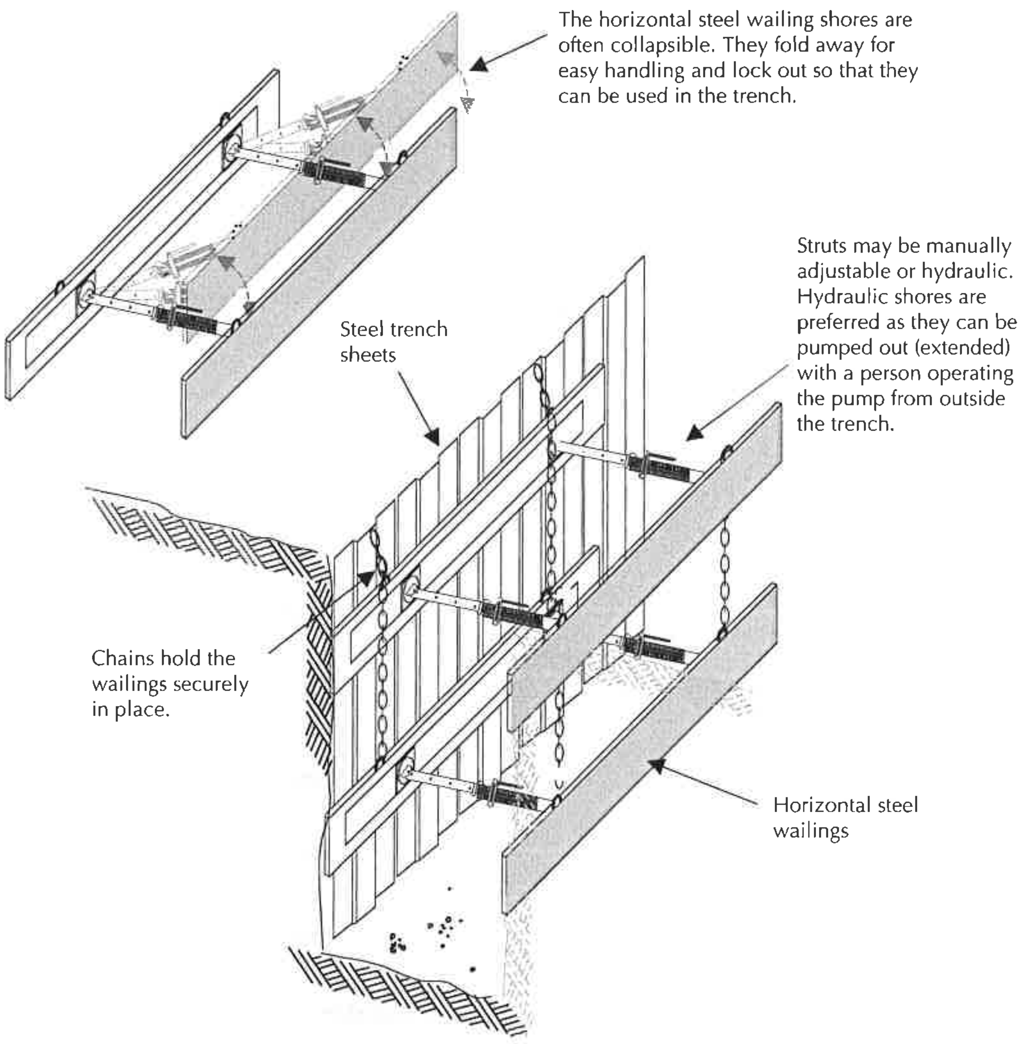


Figure 3.42 Shoring: horizontal steel wailing.

For trenches in dry granular soil it may be necessary to use sheeting to the whole of the sides of trenches. Rough timber sheeting boards are fixed along the length and up the sides of the trench to which poling boards are strutted, as illustrated in Figure 3.38. The three basic arrangements of timber supports for trenches are indicative of some common systems used and the sizes given are those that might be used.

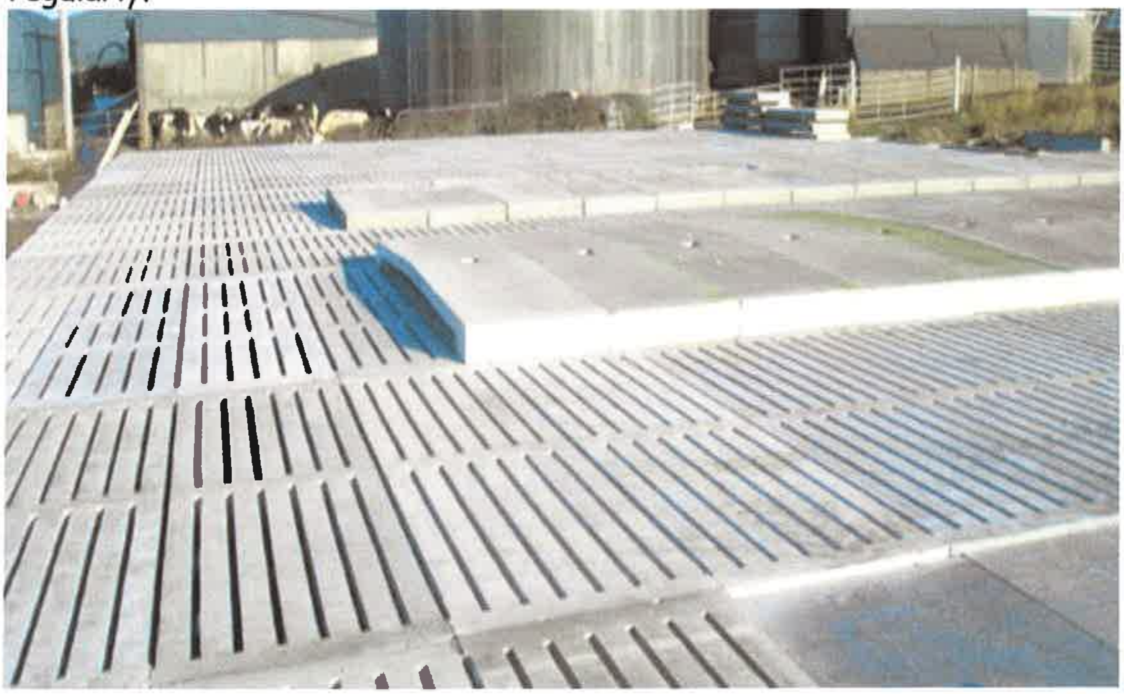
Although the traditional method of timbering is still used to provide temporary trench support it is more common to use steel shoring systems such as steel walers, adjustable vertical shores, adjustable props, trench sheets and trench boxes as illustrated in Figures 3.39–3.43.

Chapter 3: Topic Information

Main Functions of a Slatted Shed

- Shelter- to protect the cattle from the elements during the harsh winter months.

- Disposal and Storage of Livestock wastes- can be used as fertiliser when the ground is drier. Slated tanks are very useful in the fact that you don't have to keep cleaning them
regularly.



- <u>Separation of animals-</u> To prevent bull calves mixing in with heifers, a gates system is used to prevent unwanted pregnancy and aid selective breeding.

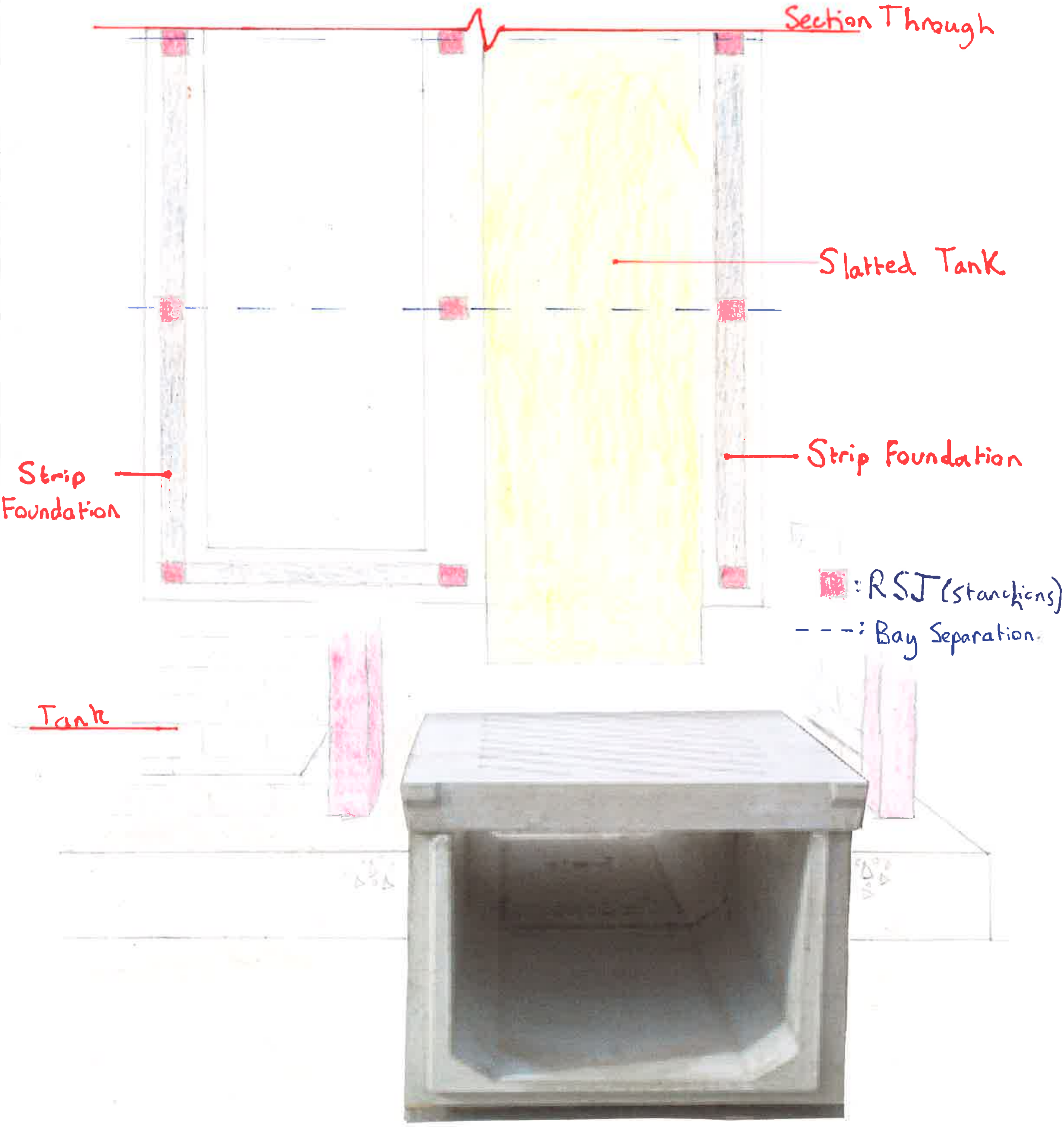
- <u>Light (electrical and natural)-</u> electrical lighting is useful during the night to check up on cattle. Clear acrylic 2.4m sheeting is used to allow natural light into the shed during the day. Without lighting, cattle tend to get depressed and are therefore more prone to sickness, not eating properly and aggressiveness.

- Plumbing- Cattle must be provided with drinkers providing fresh water. The pipes leading to the drinkers should be well insulated to prevent water freezing in the pipes.

- Agitation Points- The slurry must be mixed from time to time with a mechanical agitator to prevent it from hardening.

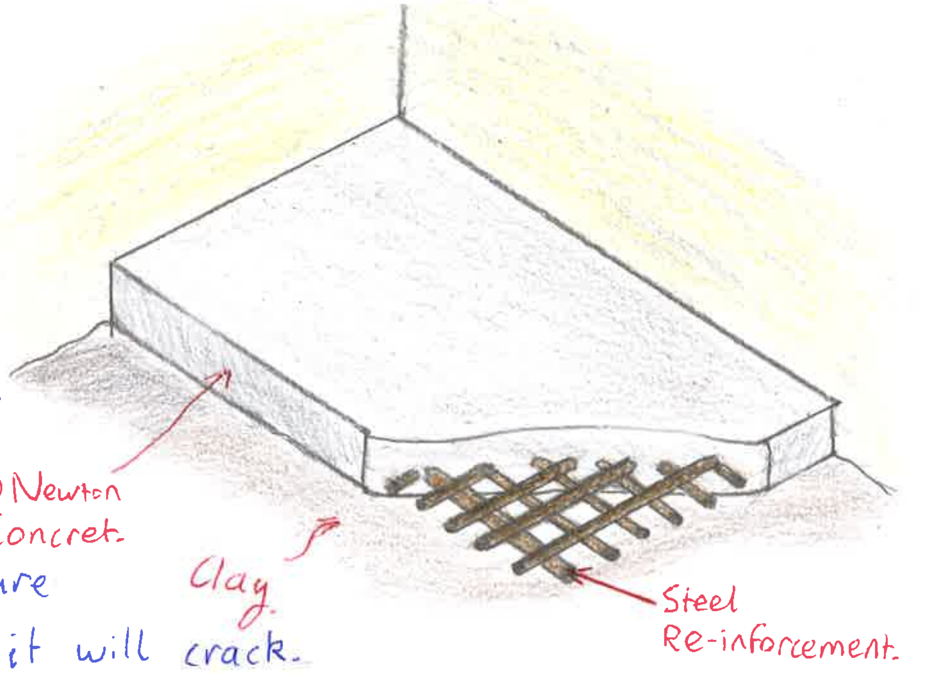
- <u>Ventilation-</u> Slatted houses can be suffocating without proper ventilation, what with the lack of moving air, the fumes of slurry, smell of silage and the collective body heat of the cattle in the shed. Ventilation must be provided to prevent lung problems in the cattle.

Plan of Foundations

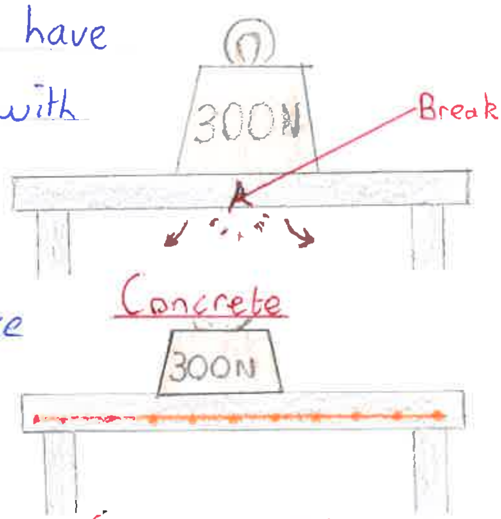


A Pre-cast Tank is first fitted into a pit excavated to suit said tank. The soil is then refilled around the tank. Then tracks for the strip foundations are dug out and the stanchions are fitted in place.

Concrete with Steel Re-inforcement.

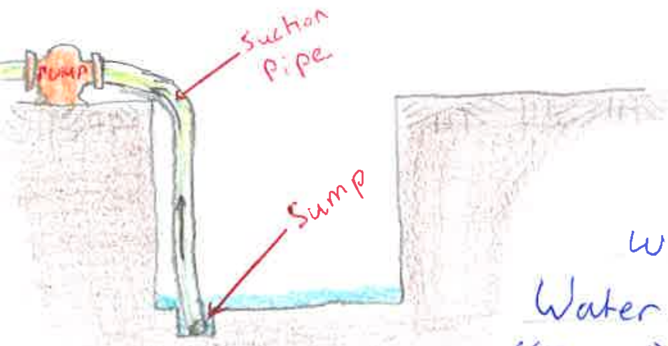


30 Newton Concrete is used in the "walk" or "feeding passage" of the Slatted House. However, concrete is strong in compression and weak in tension, so when a load is placed on pure concrete, chances are that it will crack. Hence, steel re-inforcement is required to give the concrete strength. Steel used for reinforcement is "mild steel" and should have a failing stress between 450 - 500 Newtons. Deformed (twisted) bars that are ribbed have a stronger grip on the concrete than with a round surface. Don't worry about the steel / concrete expanding at different rates, breaking the joint, because coincidentally, concrete and steel expand and contract at the same rate.



Concrete with Steel Re-inforcement.

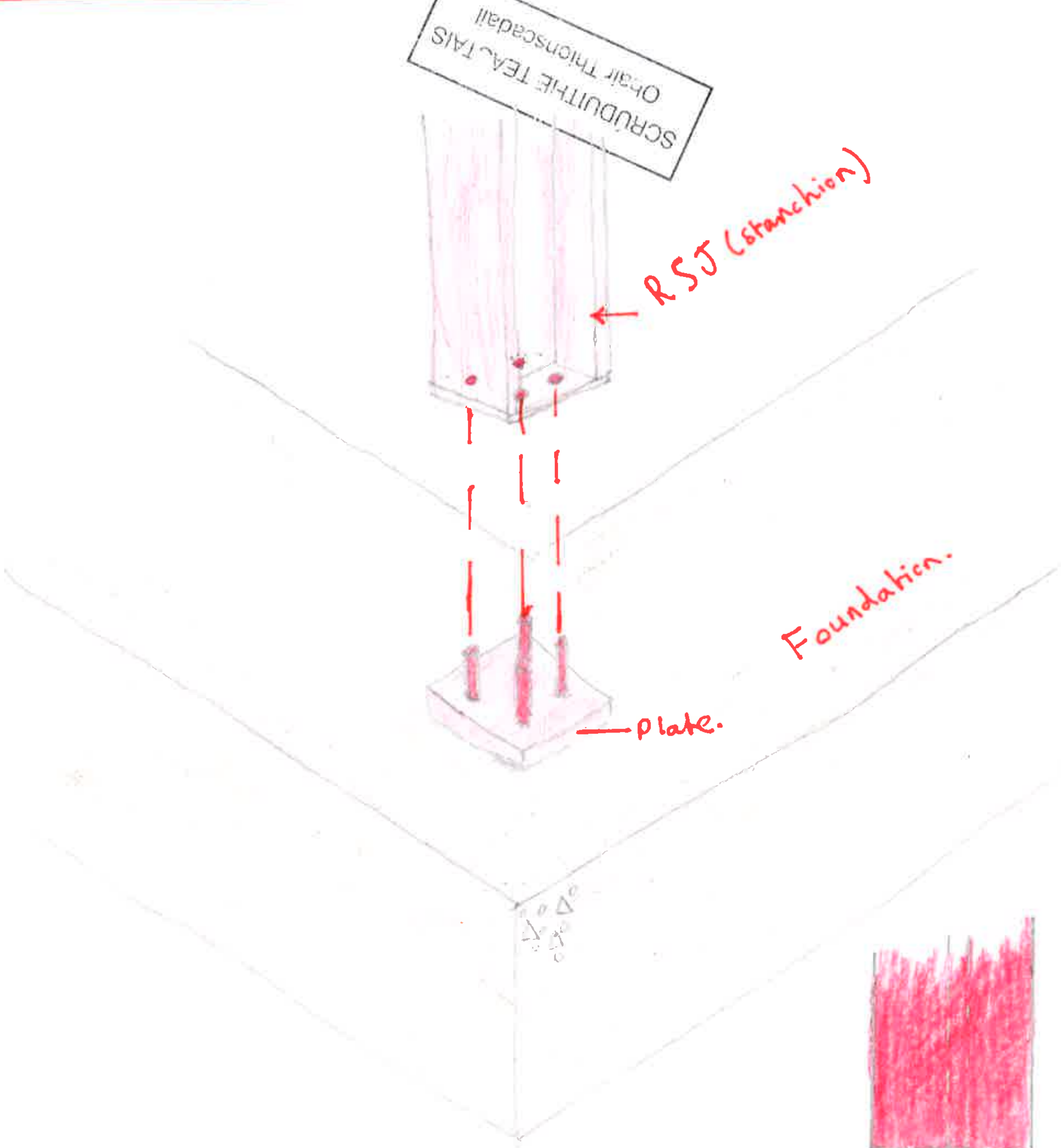
Preparation of the Concrete Foundations.

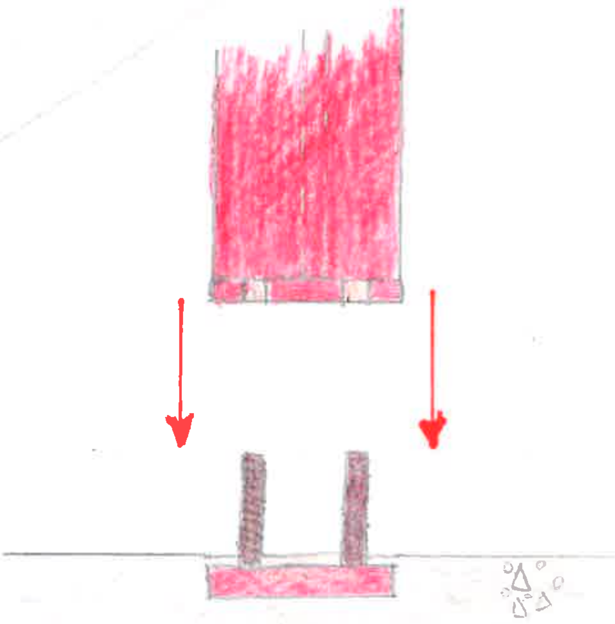


Trenches should always be drained of all water, because excess water will upset the mix of the concrete. Water should always be drained out of a "Sump" using a "suction pipe" and "pump"

* Always allow concrete 28 days to cure before you start building on it. This allows concrete time to harden.

RSJ's (stanchions)

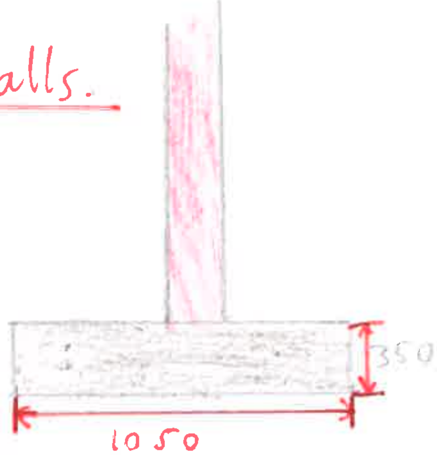




A plate with 4 holes is welded to the bottom of the stanchion. Another plate with 4 bolts protruding from it is set in the foundation. The RSJ is then lowerd and the bolts go into the holes. Nuts are then tightened down the bolts to hold the RSJ in place.

Repeat procedure for the other stanchions.

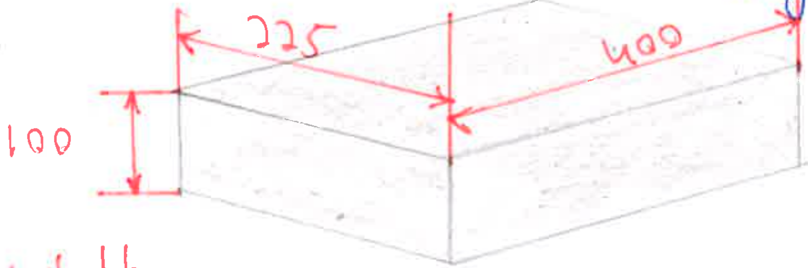
Walls.

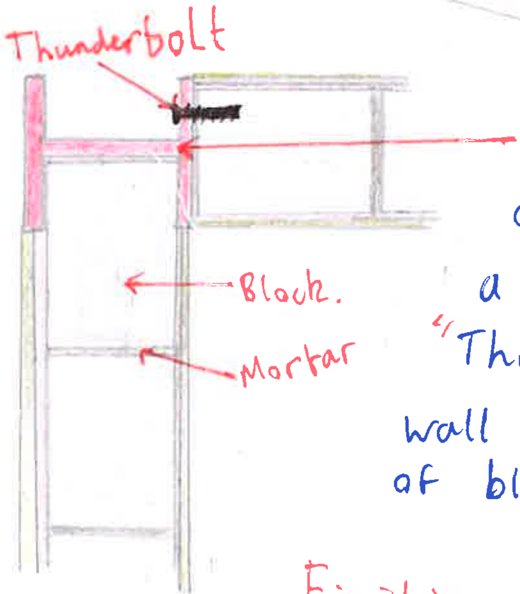


Foundation.

In this slatted house, I've decided to build the walls using Dead Building rather than pouring the walls, because you need to hire in proffesionals to shutter the walls and costs more on man-labour. Dead building can be done easily yourself.

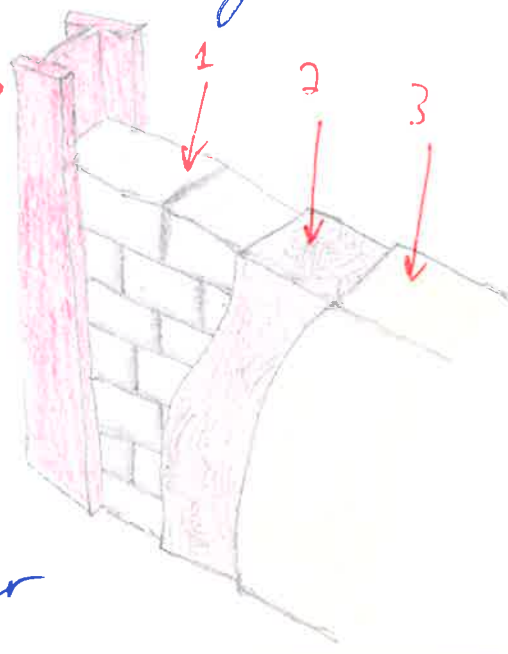
Dead Building involves building the blocks on there side and not allowing for a cavity. Cavities aren't needed because silage and the mass storage of bovine produce enough heat to supply the cattle.





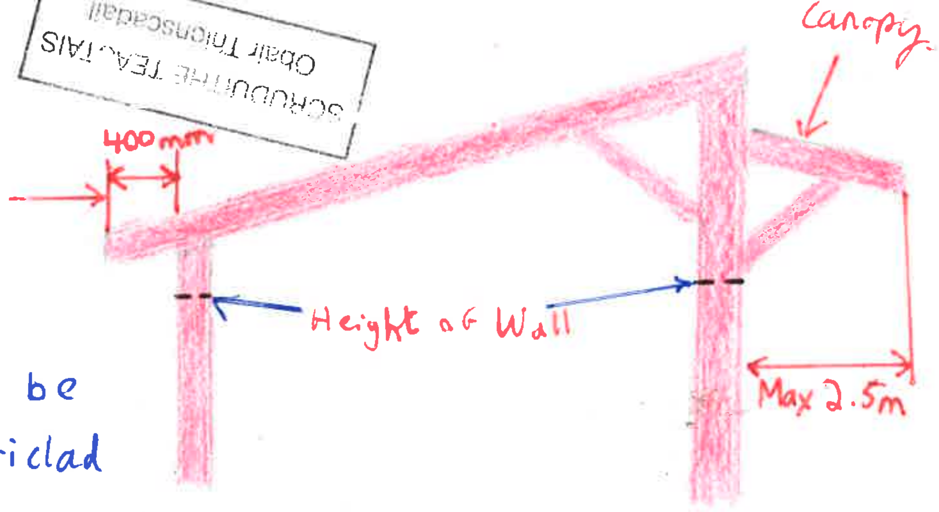
Blocks are inserted into the hallow part of the stanchion and are built out from there. At the corner of the house, a wall is added to the flat part of the RSJ. "Thunderbolts™" are then used to secure the wall to the RSJ and are placed at every 4th row of blocks.

Finishing.

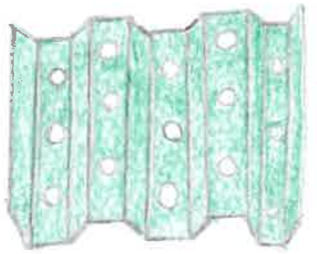


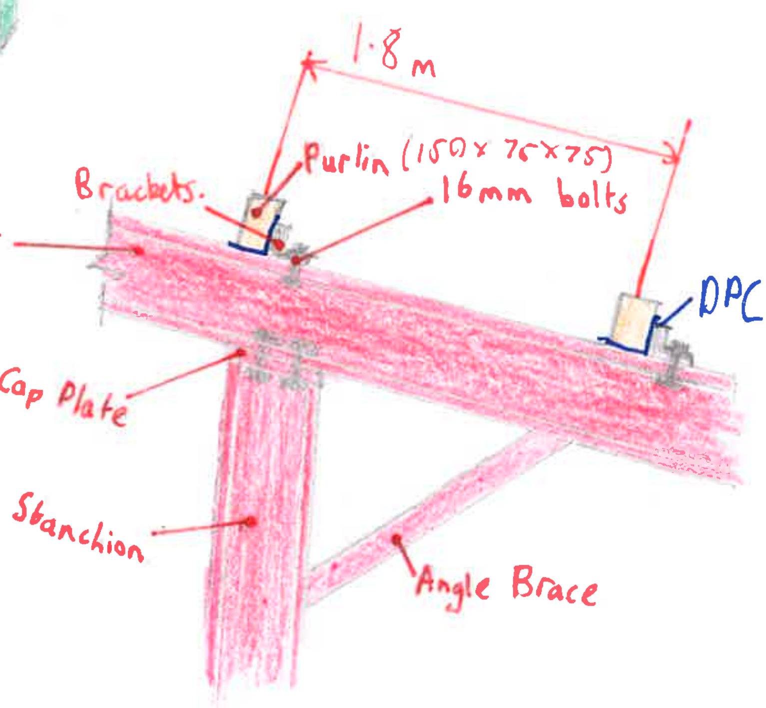
1. Blockwork: Deadbuilding. Leave 10mm gap between blockwork and Stanchion.
2. Scratch Coat: First layer of plaster. A scratched surface is used to allow the next coat of Plaster to stick.
3. Finish Coat: Smoothed off evenly. Final layer plaster.

Roofing

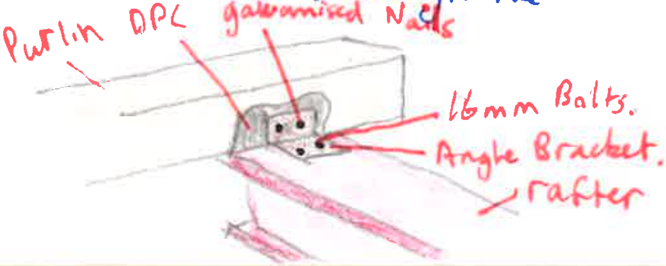


- An outer lip can be added to the outside to prevent rain from entering the building. However, this can be avoided through use of Agriclad Sheeting. The Canopy allows for ventilation, but is a big eye-sore, so agriclad sheeting may be used as a substitute.



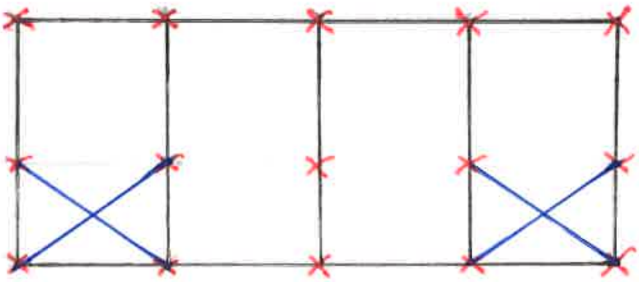


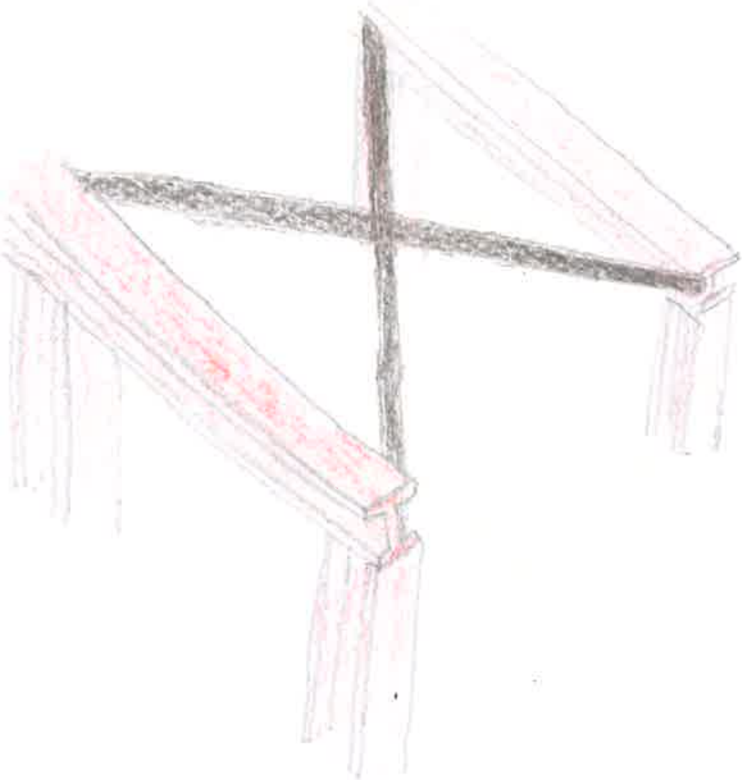
- Stanchions are the Verticle RSJs The cap plate is welded to the top of the stanchion. Holes are bored through the Cap Plate and through the rafter. Then 16mm bolts are used to bolt the two together.
- Purlins are the timber beams that run perpendicular to the Rafters. These are spaced out at intervals of 1.8m. Purlins must have a layer of DPC between the timber and the metal joints and rafter.
- Angle brackets are used to secure the Purlins to the rafter. holes are bored in the bracket to allow: a 16mm bolt to be attatched to the Rafter, and a flat headed galvanised nail that runs through the bracket, the DPC and the Purlin.



Roofing Continued....

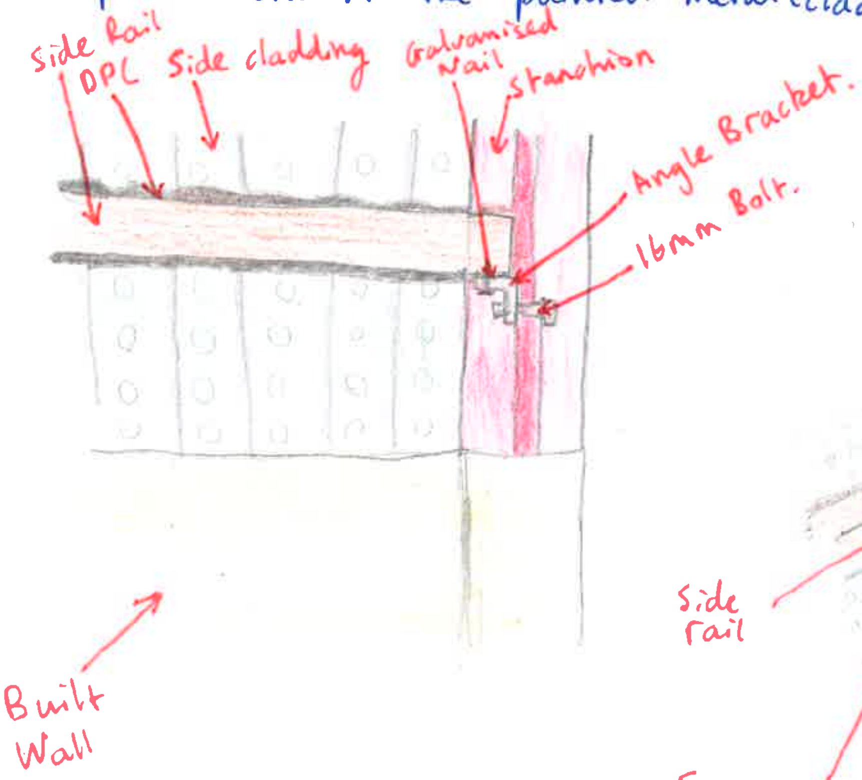
Cross-bracing: Used in the lowest external corner of a slatted shed.

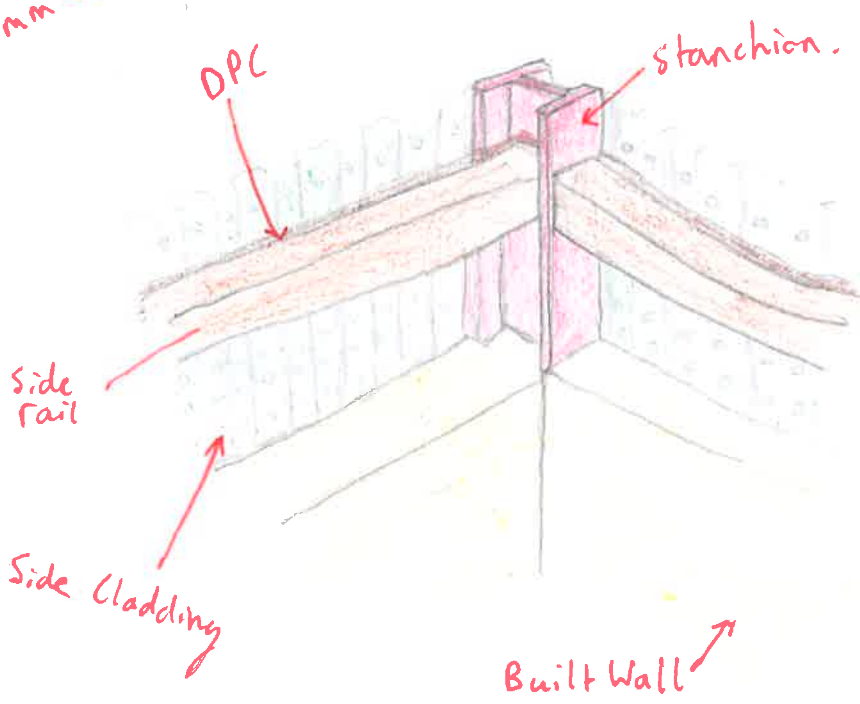




This helps strengthen the structure against high winds.

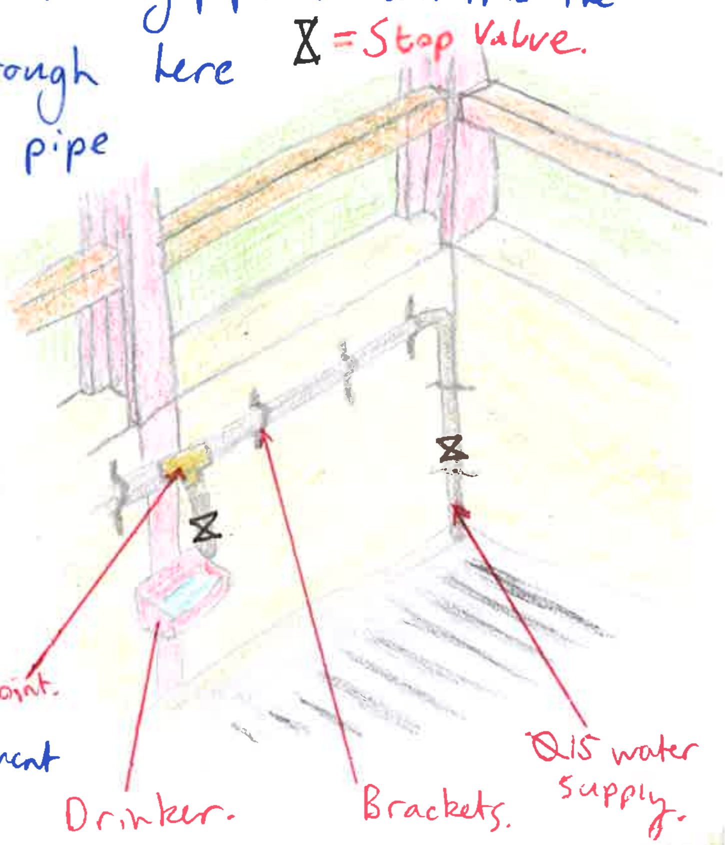
Side Rails: Used to support cladding on the side walls. They are 150x75x75mm and are slotted into the hallow of the stanchion and are supported by angle brackets. A layer of DPC must be placed between the painted metal (cladding) and the stanchion.

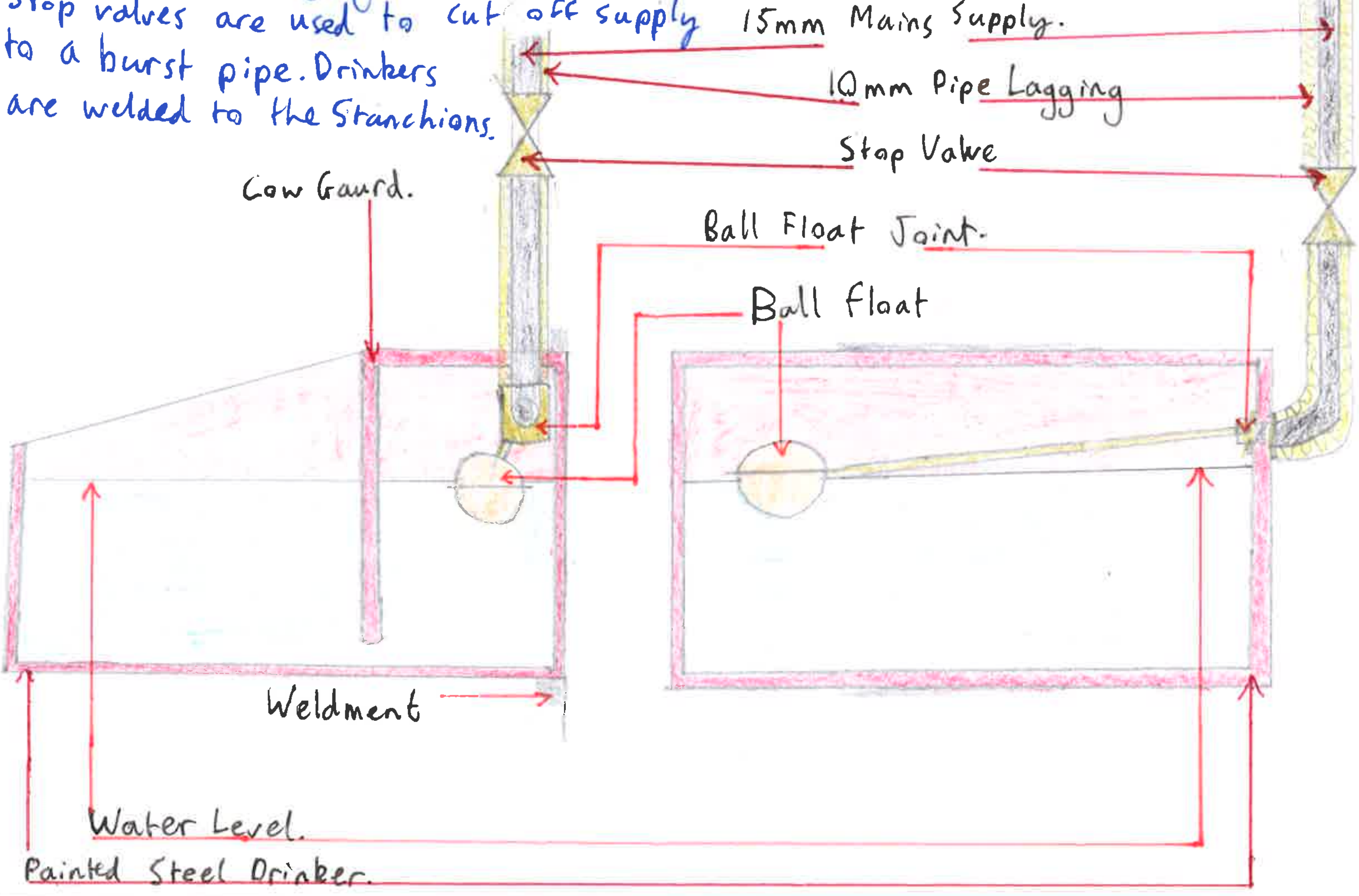




Water Supply

The Water Supply is taken straight from the mains in a Ø15mm plastic pipe. A piece of waring pipe is built into the wall and the water pipe is fed through here and up the inside of the wall. The pipe must be covered in 10mm thick pipe lagging, to prevent water freezing in the pipes during the colder months. The pipe is then secured to the wall using pipe brackets. A T-joint splits the flow of the water down to a drinker containing a ball float. A cow-gaurd is used to prevent cattle from damaging the ball float. Stop valves are used to cut off supply to a burst pipe. Drinkers are welded to the Stanchions.



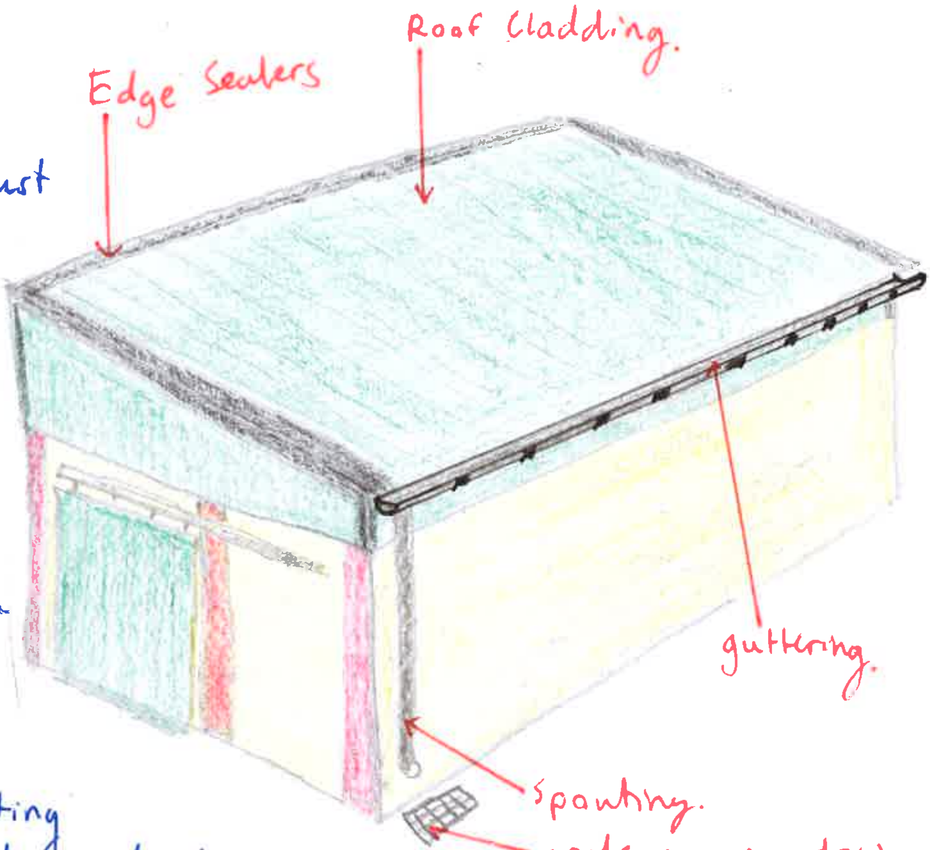


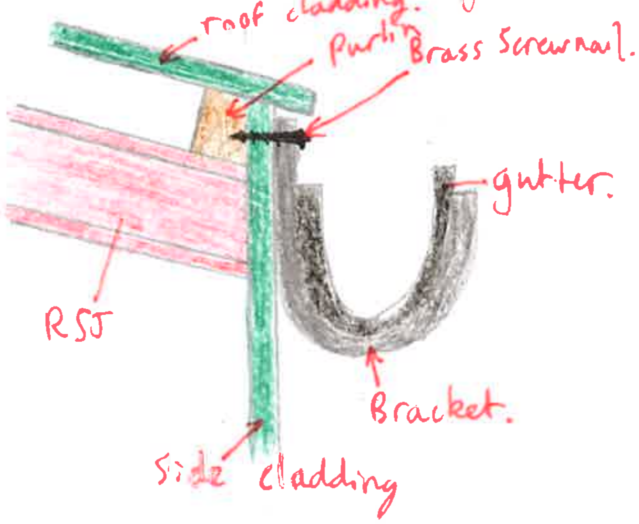
Drainage

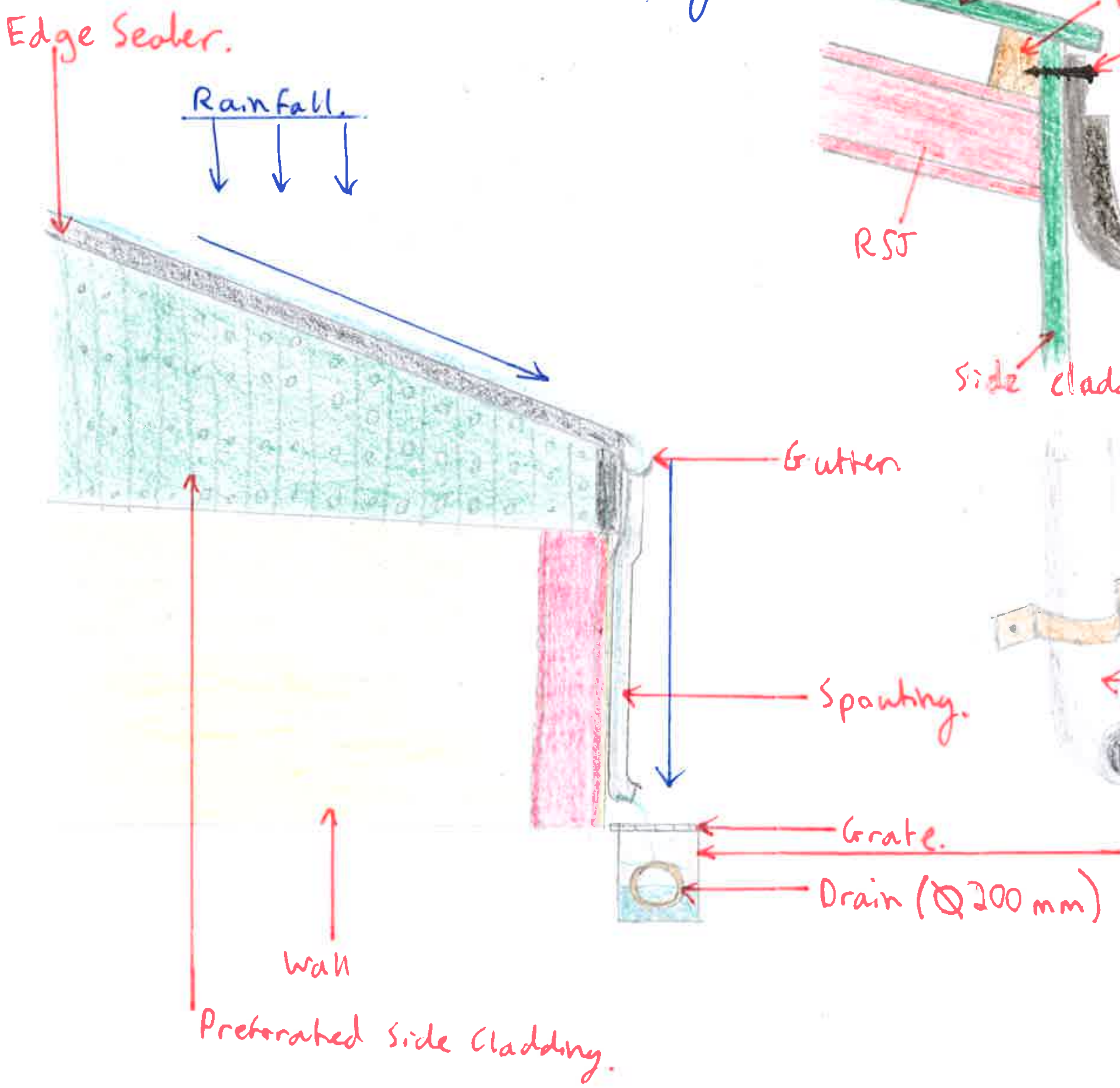
Rainwater from the roof must be channeled to a drain to:

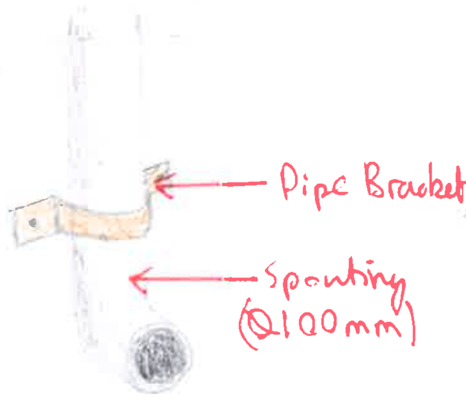
- Prevent water hitting your head as you walk past and to
- Prevent rain water from staining the side of the building.

Water runs down the roof cladding and into the guttering. It's then chanelled down the spouting and into the drain. Edge sealers seal the joint between Roof Cladding and Side cladding.

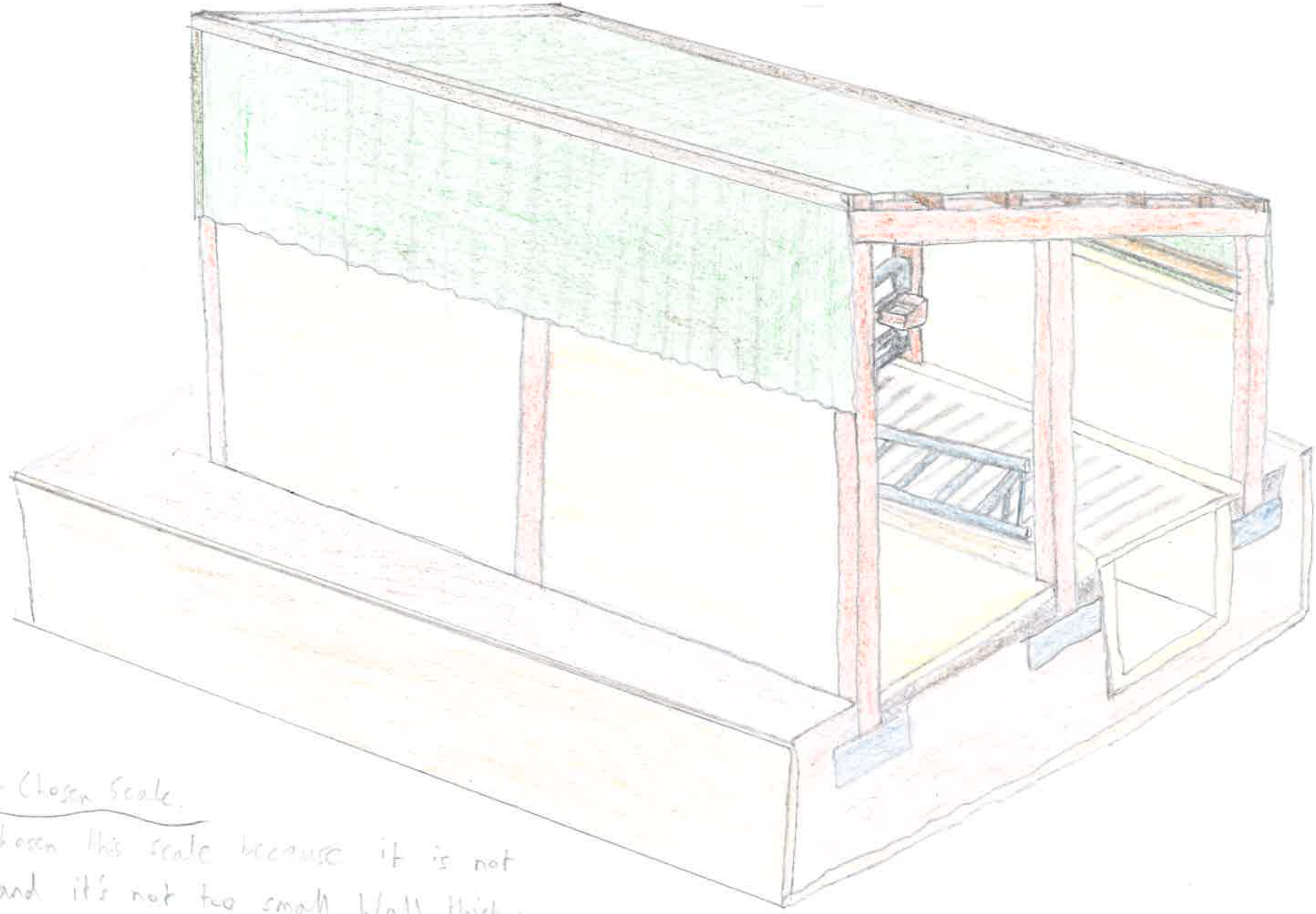






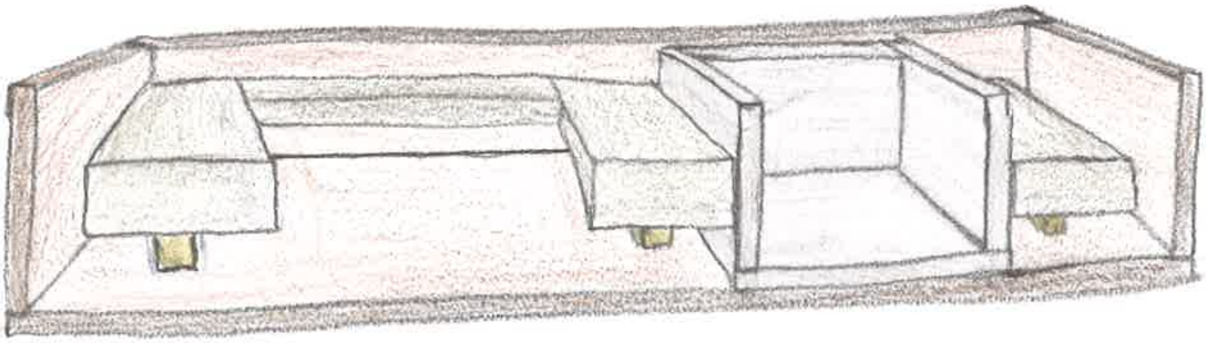


Chapter 4: Realisation

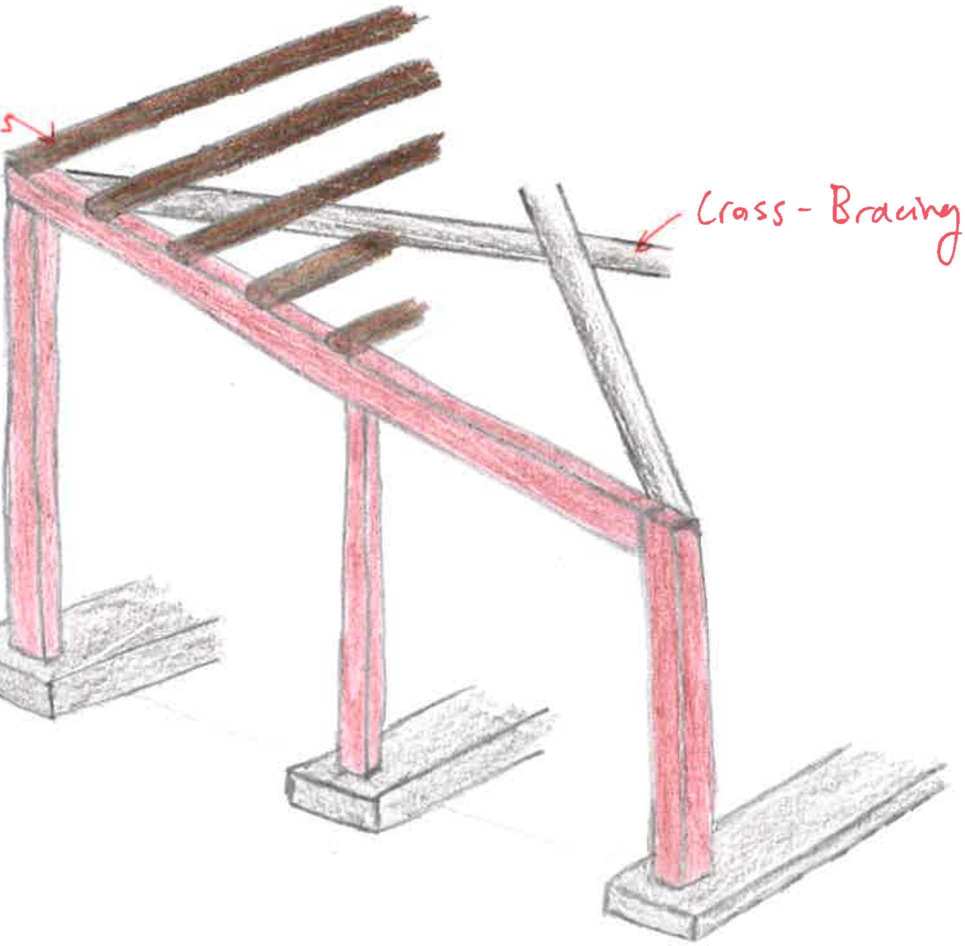


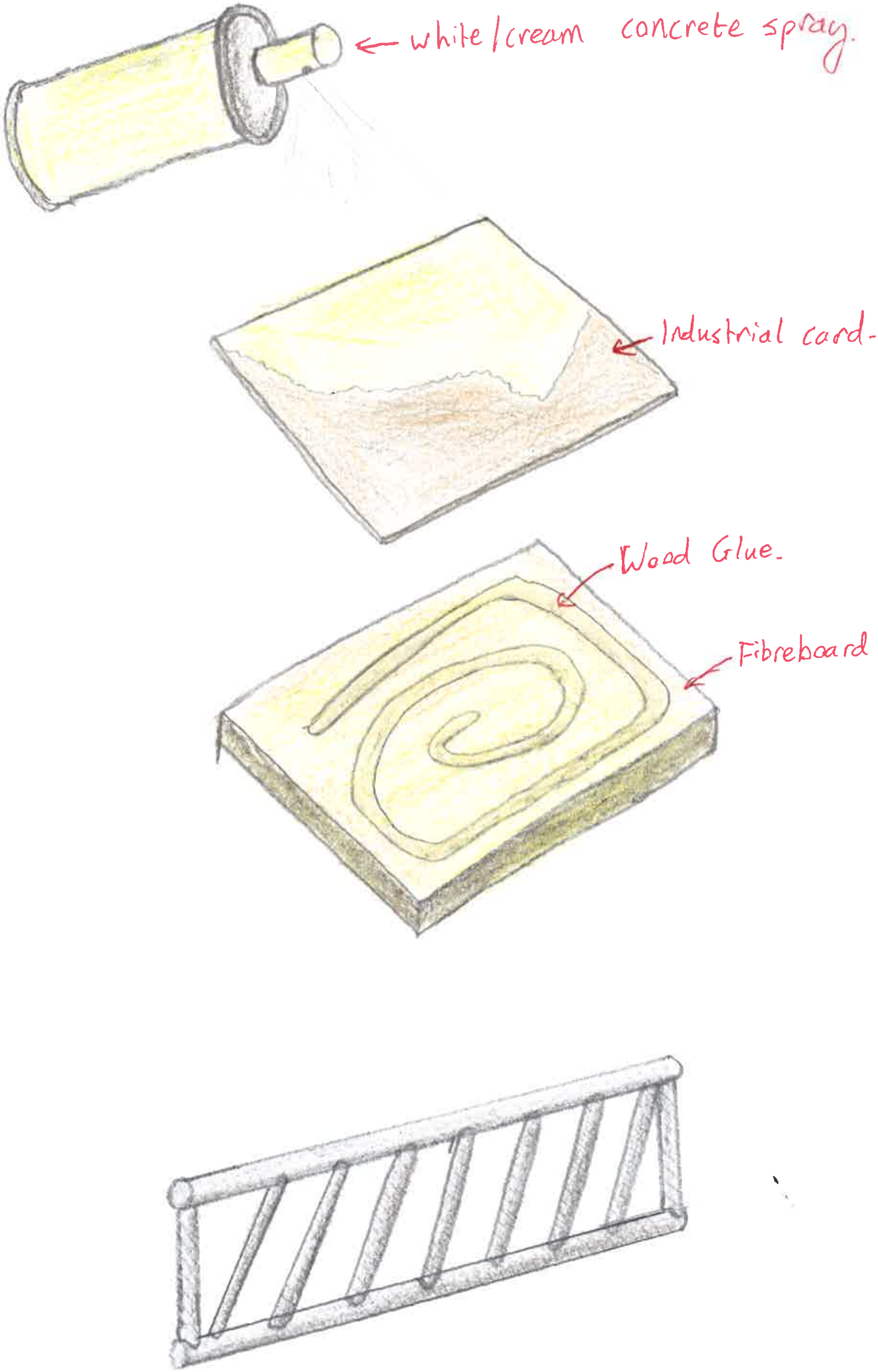
1:25 - Chosen Scale

I've chosen this scale because it is not huge and it's not too small. Wall thicknesses are appropriate since 12 millimeter and 9 millimeter boards are in proportion to the natural proportions of the building



Base


Purlins
Timber strips.
Painted Brown
Cross-Bracing: ·Dowel Rod
·Sprayed Silver


white/cream concrete spray.
Industrial card.
Wood Glue.
Fibreboard

Intended Timeline

Week	Processes	Complete
Week 1	1. Write out a document with the main functions of a slatted house with appropriate pictures. 2. Go to site and take notes and pictures (Saturday Evening) 3. Look up history of Cattle Storage.	
Week 2	1. Research possible design solutions, foundations, tanks etc. 2. Write letters to various companies seeking information and plans. 3. Ask uncle for plans. 4. Go to site, take notes and pictures	
Week 3	1. Come up with idea for basic layout of the project 2. Draw Freehand sketch 3. Go to site, take notes and pictures	
Week 4	1. Look up Building Regulations on internet and in school library. 2. Apply these Reg's to drawing and make a working drawing of actual shed. Use collected info to design the project. 3. Go to site, take notes and picture	
Week 5	1. Make a working drawing of the project and make a cutting list from this that suits the scale (1:25), the proportion of the shed and material sizes. Decide on materials used. 2. Start working on actual project: cut out foundations, make rafters and stanchions, make the tank	
Week 6	1. Continue making project: Make frame to support the stanchions and the rafters while they are being glued. Make walls to fit in between stanchions. Leave one wall with a hole for the doorway.	

Week 7	1. Start making purlins and the box to hold the clay supporting the project. Make a frame to support the foundations and tank while it's in place. Make corrugated cardboard into suitable cladding and roofing	
Week 8	1. Make Doors and Gates. Make skins to cover the walls as scud coat and plaster finish. 2. Start spraying all parts.	
Week 9	1. Continue spraying and assemble the project. 2. Add water proofing to the edges of the roof and make a spouting and guttering system.	
Week 10	1. Place the project in the container and fill clay around it. 2. Make a critical evaluation of the project	
Week 11	1. Do out 3 experiments.	

Scale

I've chosen the scale 1:20 to build my project because:

- 9mm Fibreboard can be used for the block walls and will be very much in proportion to the actual building

- 12mm Red deal will be suitable for use on the RSJs and will be in proportion.

- The Project at 1:20 will be just less than 600mm wide, so it should just about fit through the average doorway so it can be transported outside of the examination room without fear of damaging it.

- 15mm thick Fibreboard can be used for the foundations and will be in proportion with the rest of the project. This means I don't have to alter the thickness of the board to achieve the appropriate dimensions.

- 1:20 will mean that the project isn't too big, and that it won't take up too much material, meaning that it's better for the environment, simply because I'm conserving that amount of materials used.

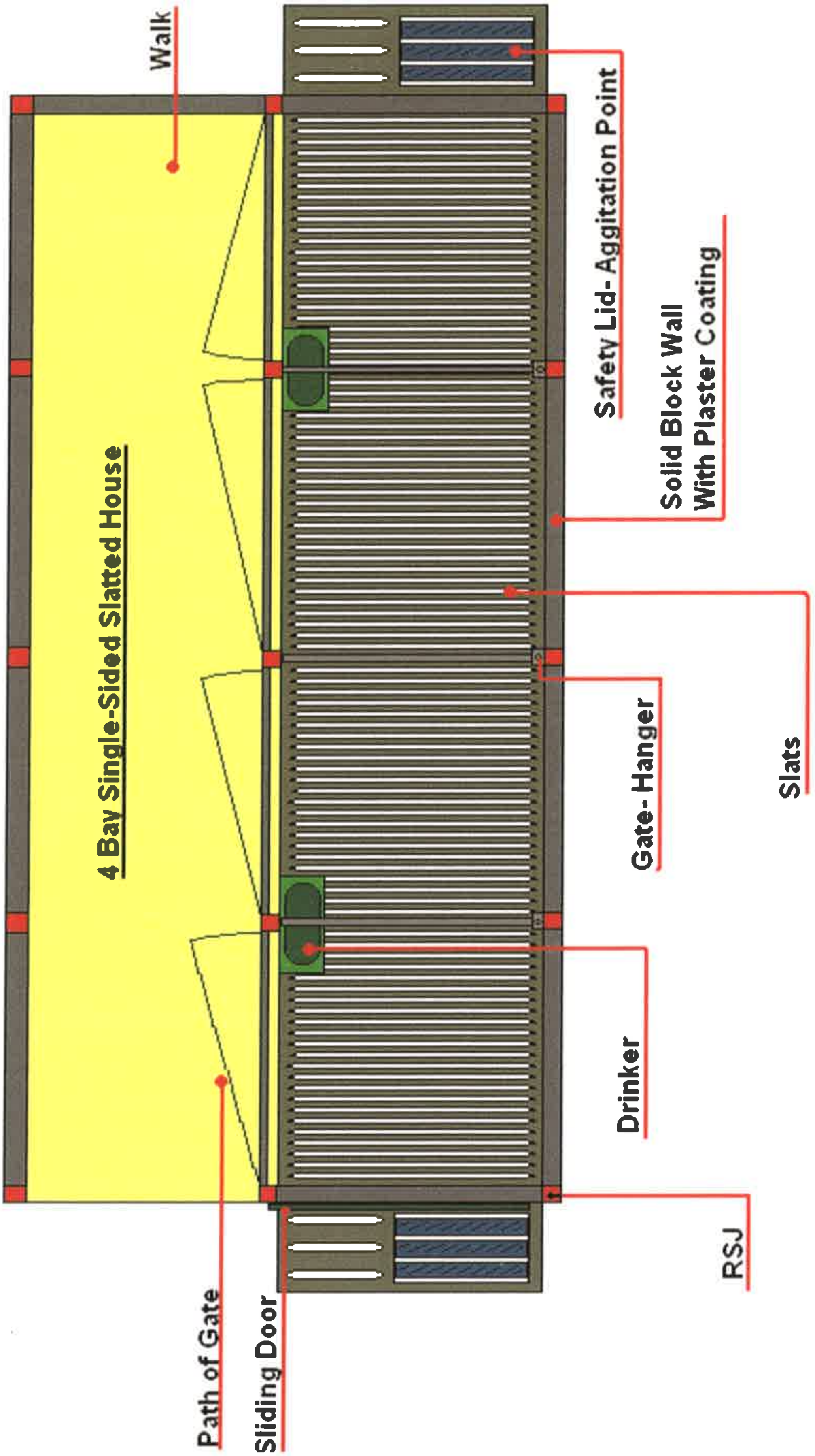
- This scale also means that the project isn't too small. Since it's of appropriate size, I can go into intricate detail in the construction of the project, and that the examiner can see all the main features of a slatted house for himself.

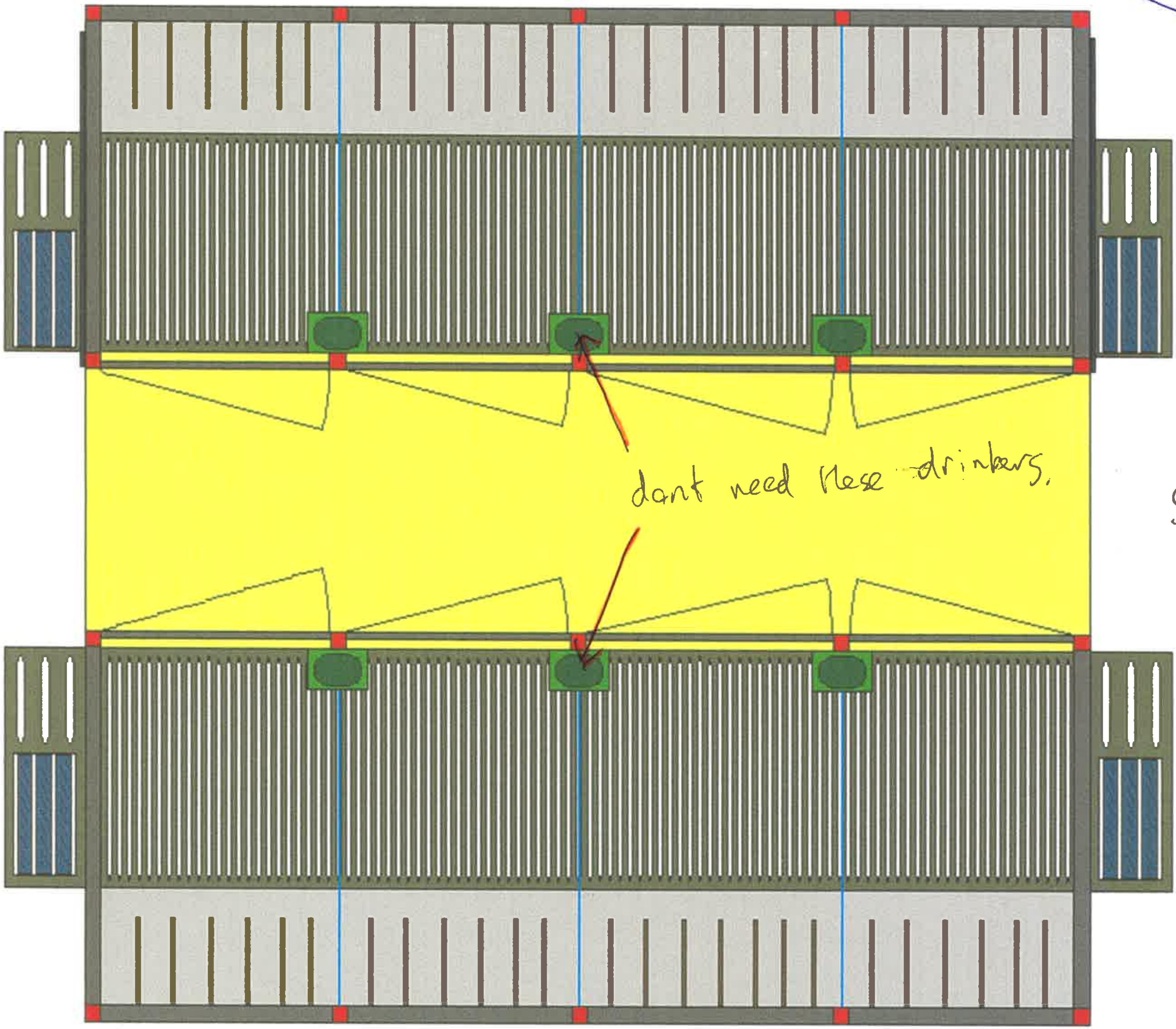
List of Materials

The choice for materials in my project is extremely important to ensure that some parts are made light and non-loadbearing and others capable of supporting weight. Without careful consideration, the project could collapse, become too heavy or too costly.

- The Walls will be made of fibreboard because they don't need to be strong since they are non-loadbearing. It is also a relatively light material so it shouldn't make a huge impact on the weight of the project.
- The Foundations will be made of fibreboard because it's very light and cheap. They'll be painted so appearance shouldn't matter.
- Red Deal will be used for the stanchions and rafters, since they have to support the roof structure and need to be strong in tension, which is a key property of Red Deal. It's also relatively cheap and is grown in local, managed forests, so it has low embodied energy.
- PVA Glue will be essential in holding the project together.
- Glue Sticks for the Hot Glue Gun will be important to hold together small, fickle joints rapidly.
- Assorted wood paints will be needed to paint the rafters, walls, walk, slats, purlins etc.
- White/cream concrete spray will produce an effect on the external surfaces walls similar to that of the actual Slatted Shed. However, it's expensive and should be applied sparingly.
- Corrugated card (which can be bought in rolls in any good stationary shop) is similar to corrugated sheeting on the roof of a Slatted Shed, and hence would help produce an accurate model.
- Industrial card is a tough, strong material that can be used to hold the concrete spray, which can then be stuck to the fibreboard wall. It can also be used to add rigidity to the corrugated card.
- Red Deal Dowels can be used to construct the gates to represent the tubular steel used in them. They can also be used to make the cross braces. These can then be sprayed silver to simulate steel.

Sample Layout of Slatted House I done on Paint





4 bay Double-sided simple steel frame slatted house - Floor Plan

only 16/17 cubicles to a 4 bay shed

Possible Solution.

My own Drawing.

Possible Plan.

Scale 1:1 Drawing

of Project

Part	Length (mm)	Width (mm)	Thickness (mm)	Material	Quantity
Small Stanchion	220	12	9	Red Deal	3
Medium Stanchion	260	12	9	Red Deal	3
Large Stanchion	310	12	9	Red Deal	3
Rafter	475	12	9	Red Deal	3
Long Foundation	505	41	15	MDF	3
Short Foundation	242	41	15	MDF	1
Slats Large Section	539	155	11	MDF	1
Slats Short Section	489	30	11	MDF	1
Purlin	503	19	5	Red Deal	5
Walls	234	170	9	MDF + Card	4
Front Wall (no door)	182	170	9	MDF + Card	1
Front Wall (door)	245	170	9	MDF + Card	1
Door	160	130	2	Corrugated Card	1
Timber Cladding Supports	239	8	6	Red Deal	4
Tank Long Wall	532	85	12	MDF	2
Tank Base	532	150	12	MDF	1
Tank Short Wall	158	85	12	MDF	1
Timber Under Gates	223	8	6	Red Deal	2
Gate Vertical	38	Ø6	Ø6	White Deal Dowel	4
Gate Horizontal	223	Ø6	Ø6	White Deal Dowel	4
Gate Diagonal	47	Ø6	Ø6	White Deal Dowel	22
Cross Bracing	485	Ø6	Ø6	White Deal Dowel	2
Box Base	595	580	11	Chipboard	1
Box Short Wall	580	94	11	Chipboard	1
Box Long Wall	595	94	11	Chipboard	2
ROOF TOP	485	245	2	Corrugated Card	1

Daniel Murray

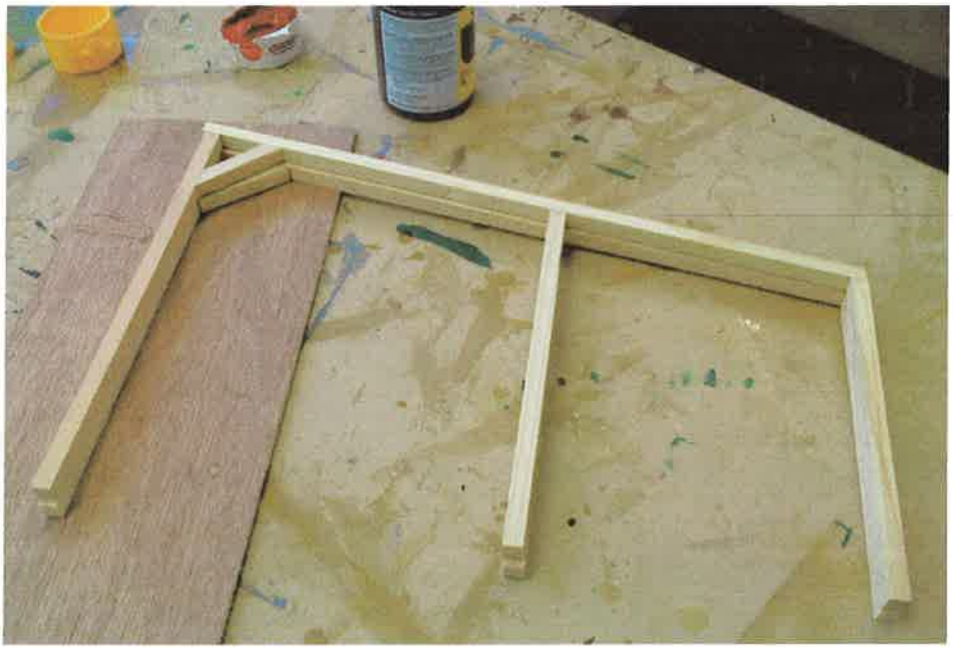
Part Name.	Dimensions	Material	Quantity
Gate Long.	Ø6mm x 223mm Long	Red Deal	4
Gate Diagnal	Ø6mm x 47mm long	Red Deal.	12.
Gate Vertical.	Ø6mm x 38mm Long	Red Deal.	4.
Stanchion Small.	208 x 12 x 12	Red Deal/MDF	3
Stanchion Med.	242 x 12 x 12	Red Deal/MDF	3
Stanchion Large	296 x 12 x 12	Red Deal/MDF	3
Door	136 x 170 x 1	Corrugated Card.	1
Roof Top.	500 x 500 x 1	Corrugated Card.	1
Roof Side Angle.	145 x 475 x 1	Corrugated Card.	1
Roof Back.	145 x 500 x 1	Corrugated Card.	1
Purlins.	495 x 7 x 10	Red Deal/MDF	8
Timber under gates.	224 x 10 x 5	Red Deal/MDF	2.
Foundations	505 x 48 x 15	Red Deal/MDF	3
Back Wall	225 x 180 x 12	Red Deal/MDF	2
Front Wall	225 x 180 x 12	Red Deal/MDF	2.
Side Wall	210 x 160 x 12	Red Deal/MDF	1
Side Wall with Door	215 x 160 x 12	Red Deal/MDF	1
Tank Side	532 x 90 x 7	Red Deal/MDF	2
Tank front.	158 x 90 x 7	Red Deal/MDF	1
Rafter	476 x 12 x 12	Red Deal/MDF	3.

Chapter 5: Execution

Step-by-Step Procedure

1. **Make the frame for supporting RSJs while gluing**: This is to ensure that the 3 base frames are cut and glued at the right intervals and at the same angles.

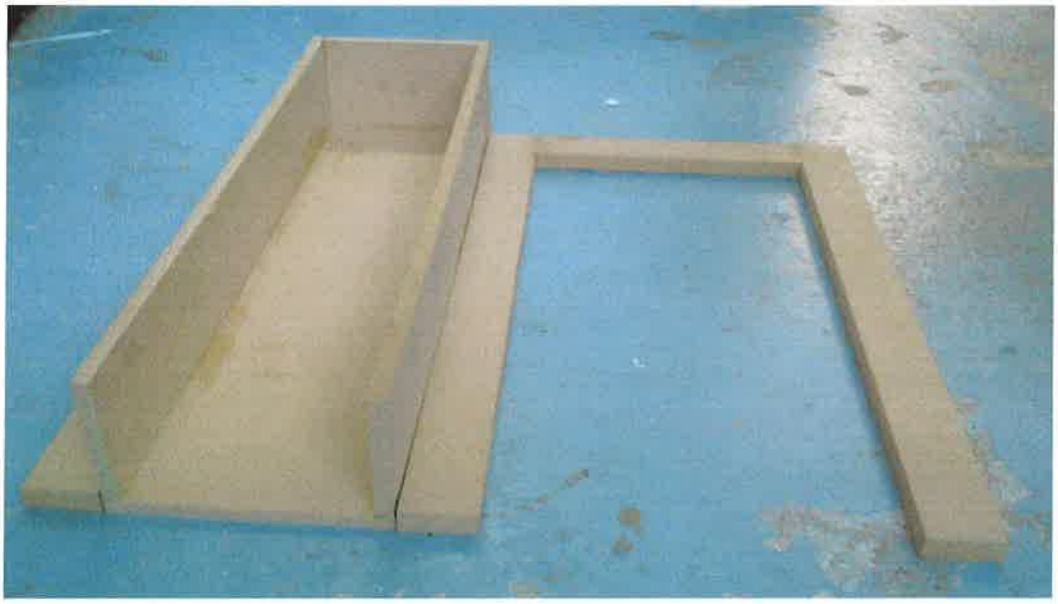
The frame consisted of four pieces of straight timber that were screwed into a sheet of plywood in predetermined positions. This one frame was used for the three sets of frames that consisted of 3 stanchions, a rafter and an angle bracket. Here we see two assembled and glued frames:



2. **<u>Making the Tank and Foundations:</u>** This is the first stage of the construction of the slurry storage tank. It's going to be made using fibreboard because it's cheaper than softwoods or hardwoods and is better for the environment.

The tank consists of one base and three walls. One side of the tank remains open because it is where the tank comes in contact with the cross section of the house.

Next we construct the strip foundations of the house. One side of the foundations go on one side of the tank, while the other side contains two sets of foundations. These foundations are required to keep the stanchions in position and to minimise movement of the house in the soil.



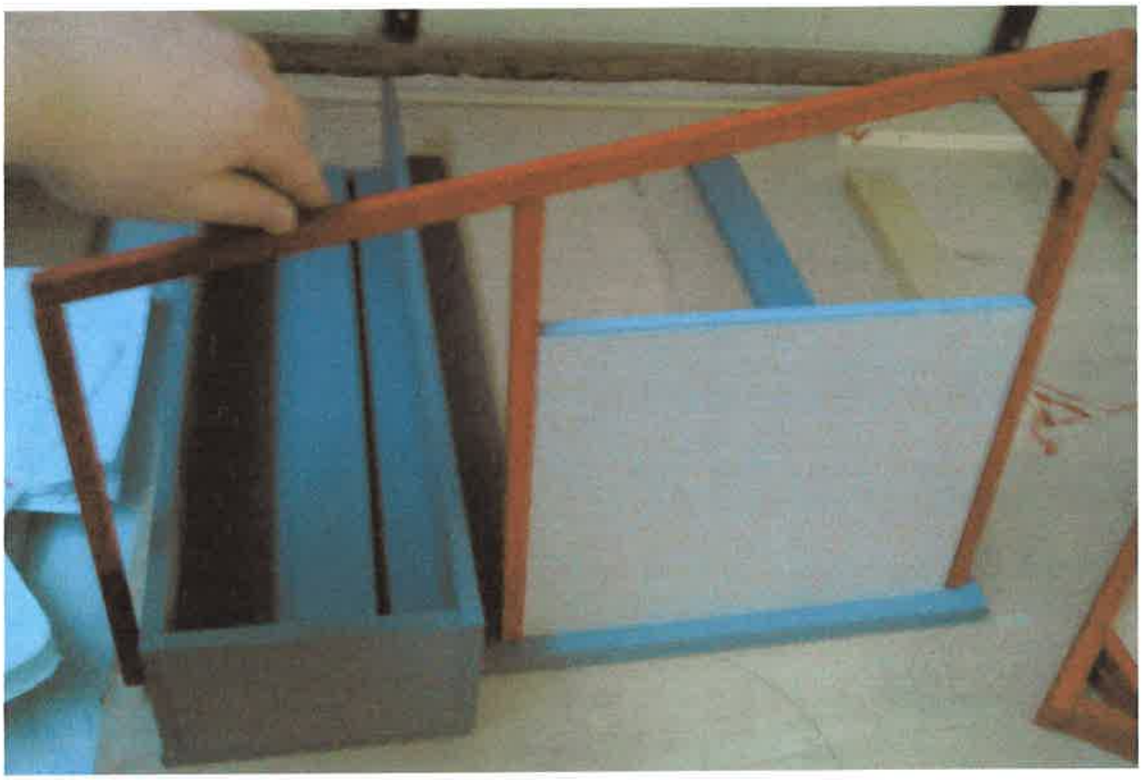
Step 3: Making the walls: The walls are made using a couple of processes.

- The fibreboard walls are cut out to fit the intervals between frames.
- A piece of thick card is cut to suit every wall.
- These cards are sprayed with a whitish cream concrete spray. This represents the special outer plaster used on the external walls. This plaster is exposed to the elements, yet it doesn't require paint or any other finish.
- The interior of the wall on the fibreboard is painted a light grey colour to represent the cheaper, interior plaster.
- The card is then glued to the fibreboard.
- One of these walls contains a door so cut the hole for the door out from the wall using a band saw.

Step 4: Painting the Frame, Tank and Foundations:

- Paint the frame a red colour, since this is usually the paint used for painting RSJs.

- Paint the tank and the foundations a darker grey colour to represent the colour of the concrete foundations and the colour of the block built tank.



Step 5: Making the Timber Supports for Side Cladding

These are relatively simple to make.

- Simply cut out lengths of 8x2 mm red deal to suit the respective length of the walls.

- Then paint them brown to represent the creosote the timbers are dipped in.

Step 6: Making the Purlins

- Cut out five strips of 8x6 mm red deal with a length that covers the 3 rafters.

- Then paint them brown and attach them to the rafters at 5 equal intervals using wood glue. Lay pieces of relatively heavy timber on top of them to hold them in place while they glue

Step 7: Laying the Crossbracing

Cross Bracing is essential to prevent the shed from swaying during Strong Winds. Basically round bars are attached to the rafters from corner to corner at both end bays. Since this is a cross section, only one set of crossbraces are visible.

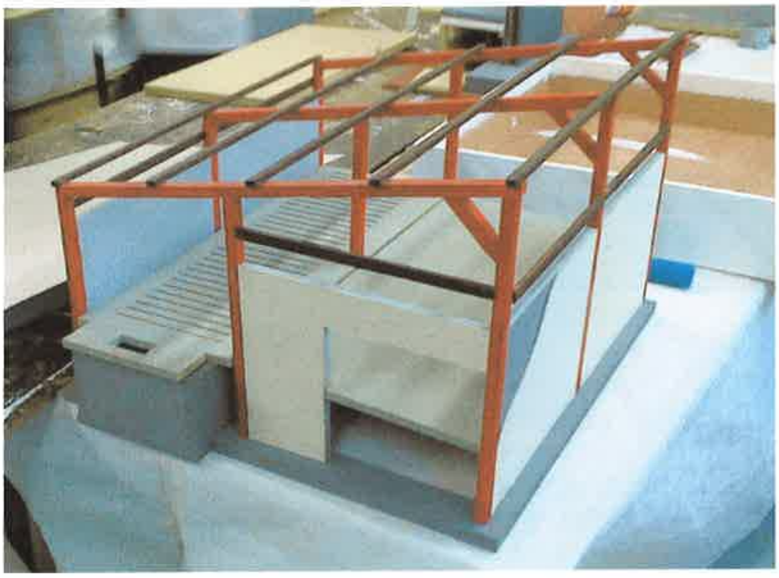
- Cut out to dowels long enough to reach from one corner to the other.
- Then sand a chamfer into the faces so they sit nicely with the rafter.
- Then paint the cross braces light grey to represent the steel of the crossbraces.

Step 8: Cut out the slats.

- Cut out a length of fibreboard that will cover the slatted area and one side of the wall. Horizontal cuts are cut to represent the holes for the slats. These holes will cover the interior of the tank within the walls of the house, while the rest is left uncut.
- Next, we cut out a rectangular hole outside the house over the tank for a port for the Agitation Point.
- Then we cut out another length of fibreboard to close off the holes in the slats. Notches will be cut to accommodate the stanchions in the middle of the shed.
- Glue these two parts together and paint a light grey colour with a tinge of brown to represent the moulded concrete slats.

Step 9: Making the Feeding Passage

- Cut out a length of fibreboard that will fit into the space left for the walk.
- Cut out a notch that will fill the hole created by the door.
- Paint the walk the same colour as the slats.



Step 10: Make a box to store the project:

- Simply make a box out of Plywood that will accommodate the whole project. Use screw-nails to make the box strong enough to support the project.
- Paint the box all white to make it look aesthetically pleasing.

Step 11: Make support beams

- Make Support beams (three 60 mm deep, the other two 96 mm deep) out of 15 mm fibreboard.
-
- Glue them into the correct positions inside the white storage box. The 60 mm beams are to support the foundations and the 96 mm deep ones are to support the walk.

Chapter 6: Evaluation of Finished Project

Evaluation of Finished Project

1. Quality

I feel that I have created a very realistic model of a slatted shed. It's to scale and is well proportioned. It includes all the details that be present in a modern regulated slatted house. I made sure to look up modern regulations since the slatted houses built around my area were built before 2002 and the creation of government document S.101. I couldn't simply take measurements of my own shed and scale them because it doesn't have many of the features present in a modern shed.

I feel that I used all the appropriate procedures while making the house and cutting out the materials for the house. The Foundations were cut out appropriately and fit in well beside the Block-Built Slurry Tank. I did consider making cubicles for the cattle to rest at night to provide the most comfort, but since this is a slatted shed designed for beef farming, they were not necessary and would only waste the farmer more money on constructing an unnecessary feature.

Where I to do this project again, I would select a different topic since there were a lot of different pieces that required a tedious amount of accuracy. Alternatively I would only include one bay of the Four Bay Slatted House rather than the two bays I made because it would show all the same features and vastly decrease:

- The amount of materials used and
- The time taking to make the project.

2. Function

Were this project scaled up to its proper size, and the appropriate materials used, rather than MDF and Cardboard, I can safely say that this house would be fully operational:

- It includes the slats necessary for the disposal of faecal wastes.
- The agitation point allows for easy access to the slurry to spread on the fields and to mix the tanks' contents to prevent it from hardening.
- It contains the gates necessary for containing the livestock.
- The wide feeding passage allow for wide tractors to reverse in with round bales whilst allowing plenty of space to manoeuvre.
- The wide passage also allows for valuable machinery to be stored. In case the weather is freezing, the body heat of the cattle will heat the engines of the machinery so it can start easily without damaging the starter.
- The corrugated roofing allows for easy drainage of rain water.
- The inclusion of Skylights allow for natural light to enter the shed. Studies have shown that cattle have better mental health when exposed to sunlight; hence they also have a better weight when the time comes to bring them to slaughter. They also save on electricity.

3. Finish

I believed I have made good use of colour in making this slatted house:

- The RSJs were painted red that was mixed with a tinge of brown to represent the common red oxide paint used in protecting the steel from rust.
- The walls were covered on one side with card that was sprayed with concrete spray. This allows the walls to take on the appearance of the plaster used on the external walls of slatted houses.
- I painted the slats and the feeding passage the same lighter colour of grey representing poured concrete. The slats be cast in concrete with several rods of reinforcement iron.
- I painted the tank and the foundations a darker shade of grey because: 1.The moisture in the ground would make them appear darker.

  2. The blocks in the wall are a darker colour than the poured concrete of the slats and feeding passage.

- The timbers used in the shed are painted a dark brown colour to represent the creosote they are dipped in to prevent decay.

Conclusion

I've gained and improved many skills in this project.

- I've been introduced to new power tools such as the band saw and the hot glue gun and I'm more competent with using these tools than ever before. I have an interest in working with my hands so it'll probable help me if I decide to take on another project.

- I've acquired more organizational skills since I had to plan out everything I was to be doing for the project. Trying to maintain this schedule was even more of a challenge. These skills will be extremely beneficial in any field of work and will help me with my study timetable for others subjects, as well as for construction.

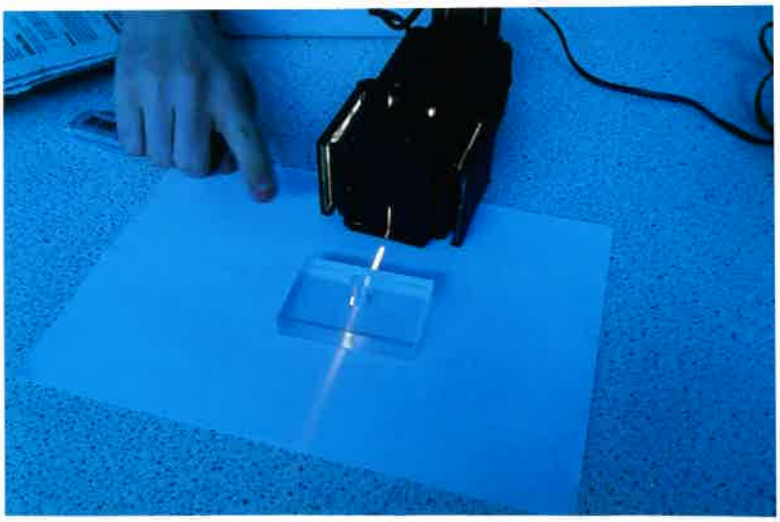
- I've improved my mechanical reasoning skills since this project consisted of a lot of different parts that required accuracy for it to fit together neatly. These skills have helped me in designing my engineering project, which also requires meticulous accuracy.

- I've improved my creativity skills because I got to work with different material to see which looks best and how they'd all come together to make it as aesthetically pleasing as humanly possible. Colour coordination will come in useful in the design of my DCG project.

- I've improved my research skills and can find key information within architectural plans and government documents. This will help me in later years when dealing with government documents because I now have the knowledge of how to find solid information amidst a ream of waffle.

Chapter 7: Experiments

Experiment 1: To show how light bends as it passes from one medium into another (Snell's Law)



Equipment:

- Block of Glass
- Drawing Board
- Paper
- Ruler
- Protractor
- Calculator
- Ray box

Method:

1. Place a block of glass on a sheet and trace around it. Then draw a line perpendicular to one face. This will represent the normal. Mark in lines that are 10°, 20°, 30°, 40°, 50°, 60° from the normal.
2. Shine the ray box down the length of each of these lines, noting the angle of incidence and angle of refraction for each.
3. Sub values into the equation: n= $\frac{Sin\ i}{Sin\ r}$
   Note: "n" is the refractive index of glass

Results: The light bended as it entered the glass form the air.

i	10	20	30	40	50	60
r	7	13	20	26	31	38

$\frac{\sin 10}{\sin 7}$ = 1.42	$\frac{\sin 20}{\sin 13}$ = 1.52	$\frac{\sin 30}{\sin 20}$ = 1.46	$\frac{\sin 40}{\sin 26}$ = 1.47	$\frac{\sin 50}{\sin 31}$ = 1.49	$\frac{\sin 60}{\sin 38}$ = 1.44

Average n = 1.47

Conclusion: Light does bend as it passes from one medium into another

	i	r
①	10	7
②	20	13
③	30	20
④	40	26
⑤	50	31
⑥	60	37

① $\frac{\sin 10}{\sin 7} = 1.42$

② $\frac{\sin 20}{\sin 13} = 1.52$

③ $\frac{\sin 30}{\sin 20} = 1.461$

④ $\frac{\sin 40}{\sin 26} = 1.466$

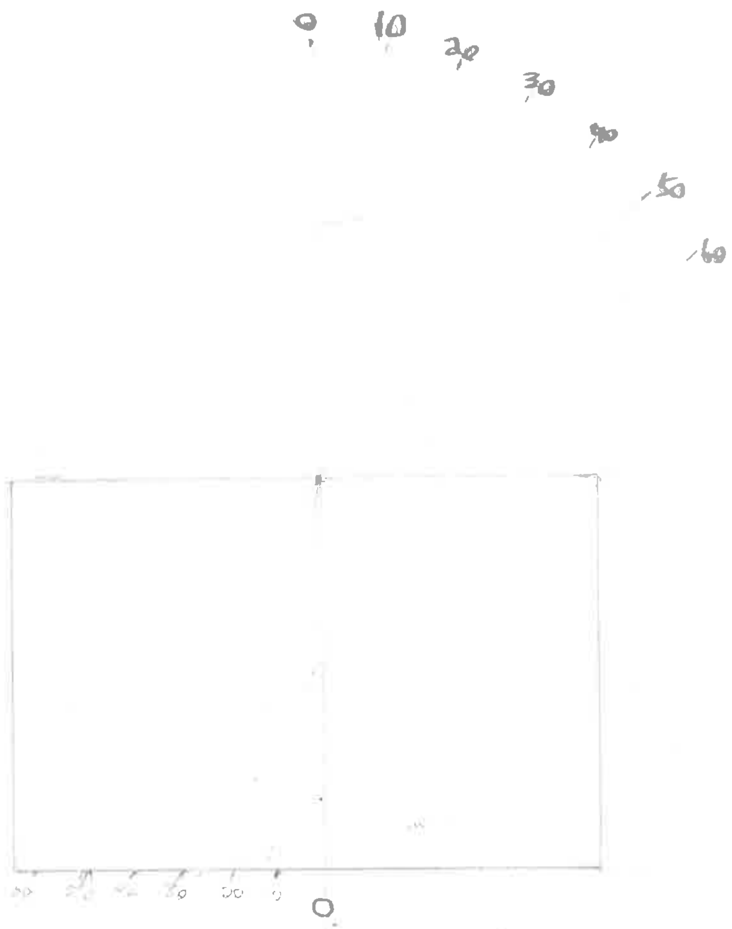
⑤ $\frac{\sin 50}{\sin 31} = 1.487$

⑥ $\frac{\sin 60}{\sin 37} = 1.439$

Average Refractive index

$$\frac{1.42 + 1.52 + 1.461 + 1.466 + 1.487 + 1.439}{6}$$

1.465 = Refractive index of Glass.



Experiment 2: To show the transfer of heat by conduction and that different metals conduct heat at different rates.

Equipment:

- Bunsen Burner
- Retort Stand
- Wire Gauze
- Metal jug
- Candle Wax
- Timer
- 3 Drawing Pins
- Rods of Brass, Aluminium and Steel of equal length and diameter

Method:

1. Attach the three rods firmly to the container using insulation tape.
2. Place wire gauze on the retort stand with Bunsen burner underneath.
3. Fill the jug with water and place jug over the burner.
4. Attach drawing pins to the end of the bars using hot candle wax
5. Boil the water in the jug and observe the pins

Results:

Times the pins fell off:

Brass= 19min 22sec   Steel= 36min 37sec   Aluminium= 14min 54 sec

Conclusion: Pin fell off the aluminium rod fastest; hence it is the best conductor of heat out of these three metals.

Experiment 3: Slump Test

Equipment:

- Ruler
- Concrete Mix
- Plastic Cup/
  Standard Truncated Cone

Method:

1. Cut the bottom out of the plastic cup
2. Fill with concrete in 3 layers of equal volume
3. Remove the container and measure the slump

Results:

(Height of cone) – (Height of mound) = (Slump)

(300mm) - (258mm) = (Slump)

(42mm) = (Slump)

Conclusions: According to European Standard EN 206-1:2000, since the slump of this batch is 42mm, it lies in the upper regions of class S1. This means it's suitable for building reinforced concrete foundations.