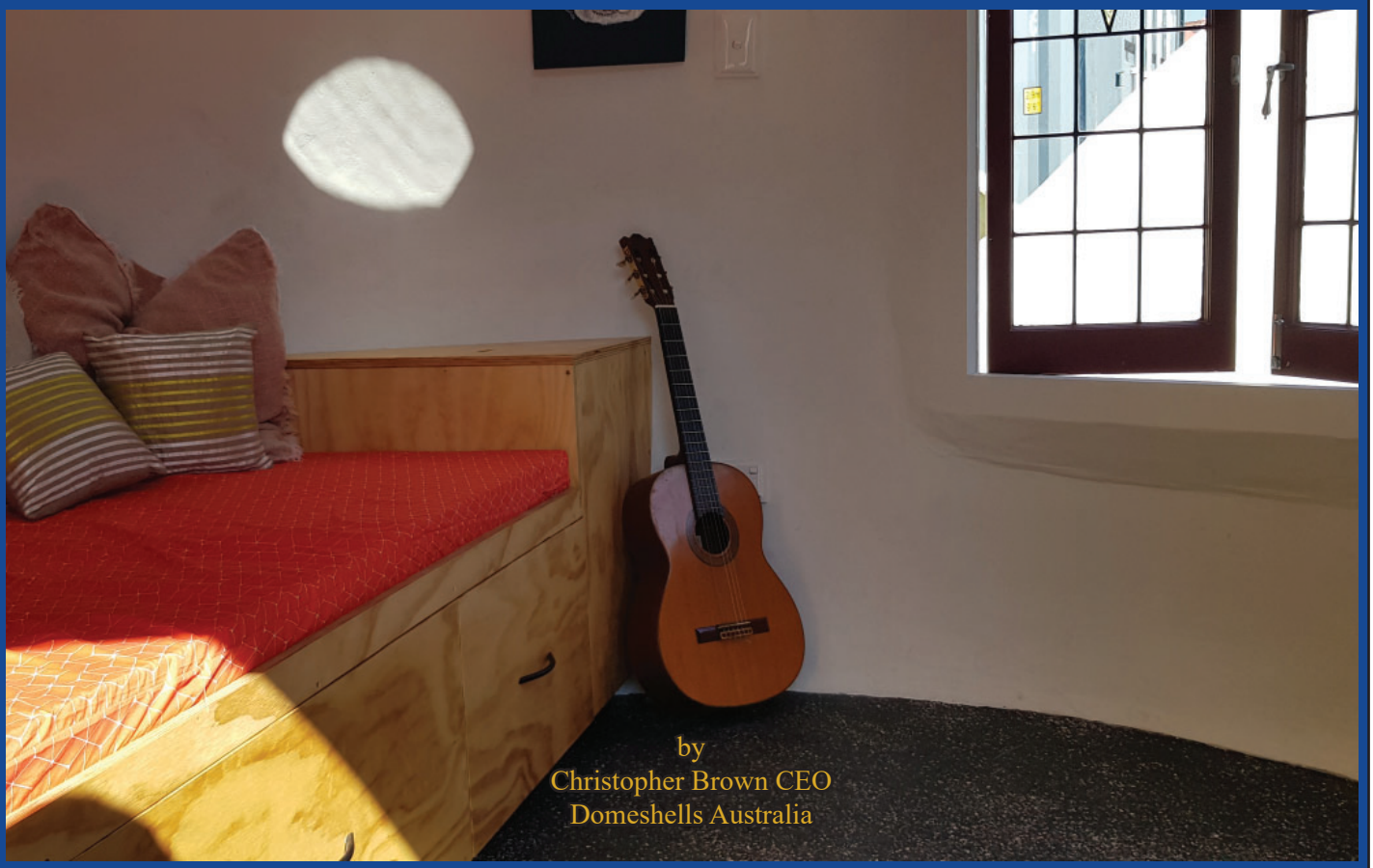
Basalt Fibre Reinforced

Dome Building Manual

Ver.3

A simple way to build
a strong comfortable 3.0m diameter concrete dome shell
Apply the principals to any size dome



by
Christopher Brown CEO
Domeshells Australia

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WELCOME!
Basalt Reinforced Concrete Dome Building Manual
A simple, sustainable and cost effective method of constructing dome shaped structures

Welcome Message from the Author – Chris Brown

Thank you and congratulations for purchasing this manual. The method and material system described in this manual is the most simple and cost effective way to build dome shaped concrete structures. Using the method described in this manual, you will be able to construct extremely strong, safe and durable forms of shelter that are capable of sustaining Category 5, cyclones and hurricanes, earthquakes and bush fire.

The dome shape, the sphere or hemisphere is inherently structurally strong, sustainable and with ethereal qualities. Inside a domes space feels peaceful and comfortable.

The method described in this manual is simple, but labour intensive and can be applicable to any size dome structure. The method can be applied to almost any shape that you can imagine and allows for great creativity in design.

In its simplest form it is labour intensive but that is one of the features that make it so appropriate for group or community projects and DIY. The simple method taught here can be combined with an air-form or a rigid mould system to almost half the time required for construction. The rigid mould system optimises efficiency for multiple dome projects (please visit the website to find out more about the rigid mould system for various size domes - https://www.domeshells.com.au)

I believe there is no other building method that offers so many superior benefits and qualities of performance against every kind of extreme event.

My greatest wish is that the information contained here will act like a seed to your creativity. It is intended be put to good use for homes, housing and shelter for yourself, family and others.

Domeshells is here for the long term and I am compelled to continually seek to improve and upgrade what we have achieved so far.

Please read through this manual fully before starting your project.

Please don't hesitate to get in touch if you have questions or a project in mind that we can help you design and build. contact@domeshells.com.au

Sincerely,
Christopher Brown
Domeshells Australia founder and CEO

TERMS & CONDITIONS

Copyright - All rights reserved. No part of this Manual, Plans, Specifications, Images together with any attachments is to be reproduced, copied, in any way or form, nor may it be stored in a retrieval system, transmitted, or otherwise copied for public or private use without prior written permission . This manual is sold according to the terms and conditions of use available at www.domeshells.com.au subject to change form time to time.

Disclaimer - The purpose of this manual (together with the "online dome building workshop") is for educational and general training purposes only, to educate and transmit information about the general understanding, skills and process of building a dome shaped shell structure using basalt fibre reinforcing bars and basalt fibre mesh and render without using a mould.

We do not guarantee that the particular configuration and specification of the workshop design we refer to in this manual is suitable for any other project. Any structure you may build for yourself is required to comply with the relevant building code and it is your responsibility to seek approval from your local authority before commencing the construction of any structure.

The exact method and principals described in this manual have been used to successfully build a number of similar structures however, this manual does not provide structural certification of any of the designs contained herein or any guarantee that the information here is appropriate for your project. It is your responsibility to satisfy yourself of the structural integrity of whatever you intend to build.

It is a condition of purchase and, or use of this manual that any person using the information contained herein agrees that they do so entirely at their own risk and the authors, Domeshells, its employees or agents shall have neither liability or responsibility to any person or entity with respect to any loss or damage caused or alleged to have been caused, directly or indirectly by the information contained in this Guide

The purchaser warrants to exercise caution and thoroughness in their approach to implementing the processes described in this Guide and to take all necessary action to ensure, that if necessary, you will seek advice and clarifications from Domeshells, obtain the services of a professional builder or engineer or obtain further training in the process of construction at a Domeshells builder training event. Ensure that whatever you do build will adequately perform its purpose.

Building Code Regulations
Australia has extremely rigorous building standards and regulations. Domeshells engineers provide structural certification for basalt reinforced concrete domes that comply with Australian building regulations for council plans and permits.
If you have a project in mind please get in touch and ask about our architectural and structural design services to produce plans and drawings that comply with the Australian Building Code for your local council.

If you do not agree to these conditions - do not proceed.

If anything is not clear to you please take the time to do further research or contact us with any questions.
Email: diy@domeshells.com.au or a phone call +61 2 6677 0216 Monday to Saturday 9:00 am to 6:00 pm (Australian Eastern Time)
https://www.domeshells.com.au

HEALTH & SAFETY

Everyone is responsible for safety.
Building work poses many inherent safety risks.
We strongly advise to take these risks seriously and therefor take every precaution to mitigate the possibility of injury.
Construction is potentially a dangerous occupation and requires consciousness of the risks and a determination to eliminate or mitigate risks which might cause injury.
In Australia anyone who works on a construction site must obtain a “construction health and safety white card”

It is your responsibility to take every precaution in the process of constructing any kind of structure and that you inform yourself of and comply with health and safety regulations pertaining to your region..
Some of the most important issues to safeguard are listed below:

Personal Health and Safety Equipment Required On Site

1. gloves
2. dust masks
3. hearing protection - ear plugs
4. overalls
5. eye protection
6. first aid kit
7. sunscreen
8. hat
9. steel capped boots

Sequential Tasks to Take into Consideration

The following list does not necessarily list every item that requires an element of labour. The amount of time taken for any manual work can vary considerably depending on the level of skill and experience of the worker.

1. Set out and excavation
2. Fabricate and install formwork slab and footings
3. Fix slab steel
4. Pour and finish slab
5. Set up centre pole
6. Install starters
7. Fabricate vertical and horizontal bars and fabricate door and window hoods
8. Fix mesh to the bar cage
9. Apply first skim render coat
10. Apply external and internal layers of render to 70mm thick
11. Apply internal finish coat and sponge finish
12. Apply external perlite layer
13. Sponge finish external perlite layer
14. Apply waterproofing
15. Hang door and window
16. Decorate

Prefabricated Elements

1. Prefabricate window and door moulds for pre-cast door and window frames/jambs
2. Prefabricate apex ring hob - this is optional as the fabrication of the hob can also be done in-situ
3. Prefabricate rebated skylight ring for glazed skylight

PRINCIPALS OF a DOME SHELL STRUCTURE

What is a shell structure? Definition from Britannica

"Shell structure, In building construction, a thin, curved plate structure shaped to transmit applied forces by compressive, tensile, and shear stresses that act in the plane of the surface. They are usually constructed of concrete reinforced with steel mesh".

Domeshell method and system

Domeshells designs and builds "thin concrete shell structures" reinforced with basalt rebar. They are monolithic shell structures meaning a single element. "A Shell" can be likened to a sea shell which is curved according to sacred geometry mathematics as a single element.

The "dome shell" built according to our method becomes a seamless shell structure.

There are many advantages of a "shell structure" design. When designed the correct way with the right materials a shell element incorporates inherent qualities of superior strength and is able to achieve significant material savings compared to conventional designs.

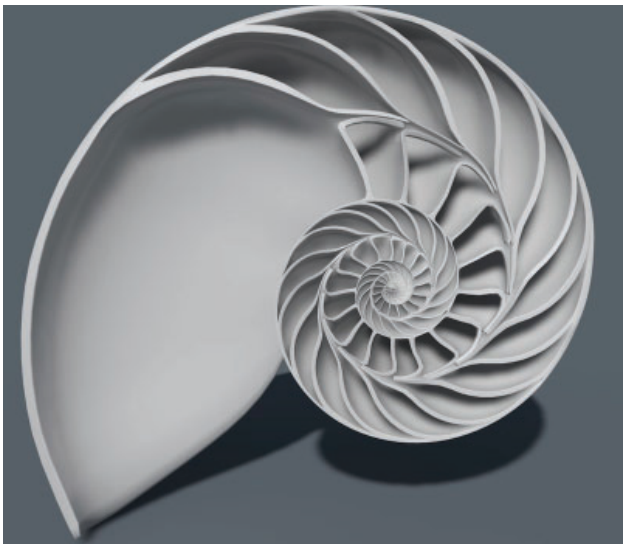
The dome shape as a concrete shell element with appropriate reinforcing is capable of much higher forces and loads than convention rectangular design.

Domeshells method described in this manual is the result of many years of research, development, design/build trial and error in an effort to find the most simple way to fabricate a shell structure.

Domeshells system utilises very simple principals that have been applied through the ages combined with modern materials to create natures most efficient shapes for housing and shelter.

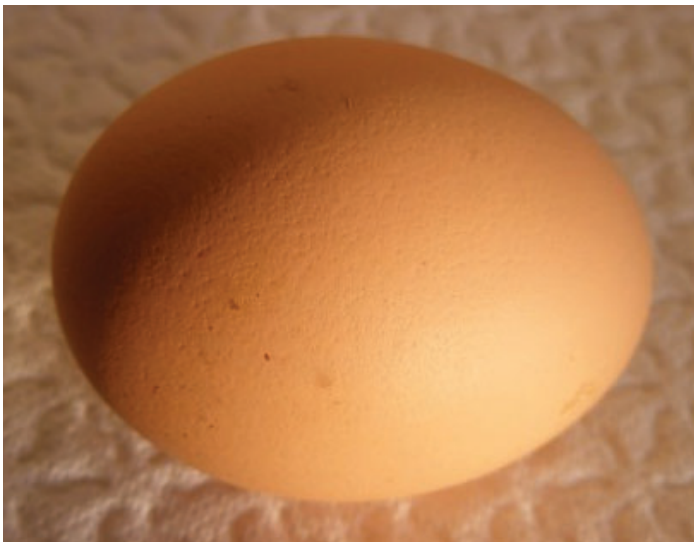
Well Known Shell Structures

Perfect sacred geometry in a thin shell structure



The most famous shell strcuture

A great example of a "thin shell" structure



Oceanographic Park, Valencia, Spain

PLANNING YOUR PROJECT

Australian Building Code Compliance

Domeshells basalt fibre rebar reinforced concrete domes can be built in any council area of Australia provided the drawings are certified by a Domeshells structural engineer.

Approvals for Local Authorities (Councils)

Our designs comply with the Building Code of Australia and in fact exceed most Australian Building Code standards. A standard Domeshells home exceeds the highest requirements BAL FZ zone under the Australian Bush Fire Code

Town planning regulations govern zoning and what is permitted in each type of zone. It includes things like it's permitted use, boundary set-backs and height restrictions of buildings etc. Talk to the "duty planner" at your local council to find out what are the zoning requirements of your land.

Getting plans through council or private certifier

Domeshells can help with drafting, architectural design and drawings and documents you will need to get your project through your local council. Please get in touch here: contact@domeshells.com.au
First place to check on the regulations relevant to your property is either the council or a "private certifier. A private certifier will provide you with a list of documents that you will need to provide and also quote to handle and process your application and make necessary inspections through the progress of the project.

Consultants you may need

Geotechnical engineer

It is a general requirement in Australia to obtain a site soil classification to allow the structural engineer to design the foundation and footings.

Bushfire consultant

Some council areas will already have a bush fire overlay that includes your site which will set the "Bush Fire Attack Level (BAL)". The BAL sets the bush fire resistance level of a home to be built. Some councils will require you to engage the services of a consultant to obtain a bush fire report from a qualified person. There could be additional consultant reports required depending on local council requirements

Architectural design

Site plan, floor plan, elevations from 4 sides and detailed sectional drawings through the building are required for a construction certificate or permit. The architectural drawings specify many aspects of the build including finish details, window types, fittings etc

Structural design

Australian councils require an engineer certified structural design drawings for footings, slabs and the shell structure. Domeshells engineer can design and certify for all Australian States

Construction certificate or building permit

This is the final document you will need to legally build your dome structure and will be issued by the local council or private certifier.

NOTE:

The plans included with this manual relate to the structure built during our basic DIY dome building workshops and are not necessarily suitable for every location. Every project is required to have a structural design that specifically relates to a specific site.

Owner Builders

We work with owner builders and help them with resources, advice and training.

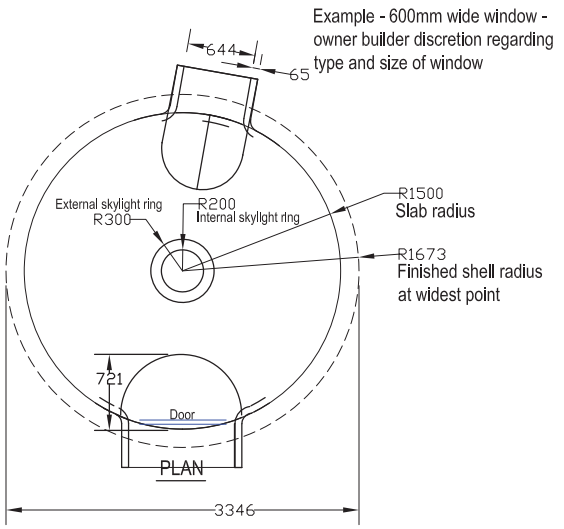
Plans and Design Detail

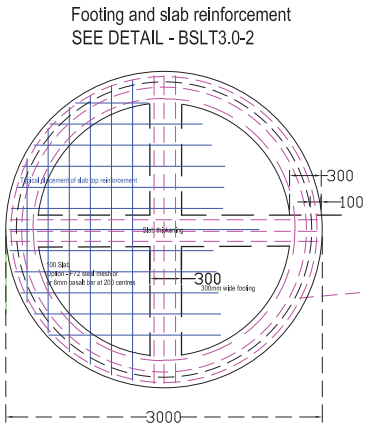
Consider printing the drawings on the following page on A3 paper
to read dimensions in the scale they are drawn

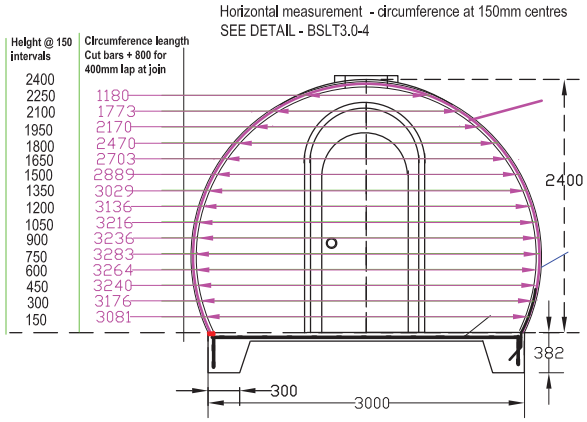
See the Full Plan Set - a separate PDF file for A3 printing

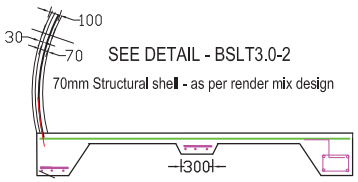
BSLT3.0-1	Overall plan, section, elevations
BSLT3.0-2	Slab and footings for slab on ground and slab on platform (relocatable)
BSLT3.0-2a	Typical slab form detail - rib plan & isometric detail
BSLT3.0-2b	Plan & section - of a platform for a relocatable slab
BSLT3.0-3	Plan & section - Vertical bar placement and assembly
BSLT3.0-4	Section - Horizontal bar lengths & placement
BSLT3.0-5	Section - Apex opening and skylight detail
BSLT3.0-6	Plan & section - Temporary centre pole and apex ring assembly detail
BSLT3.0-7	Section - Skylight ring mould & glazing detail
BSLT3.0-8	Plan & section - Apex ring beam mold fabrication detail
BSLT3.0-9	Section - Apex ring beam to Shell connection detail
BSLT3.0-9.1	Vertical section - Precast door jamb detail
BSLT3.0-9.2	Vertical section - Typical mold profile for precast door and window jamb detail
BSLT3.0-9.3	Elevation - Typical door & precast frame detail

3.0m Basalt Reinforced Concrete Dome Shell
Plan Section & Elevations



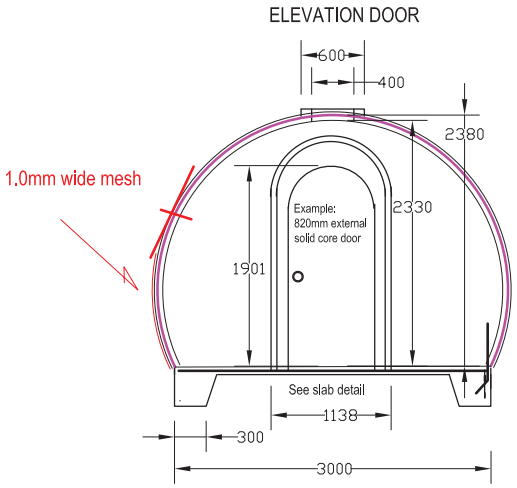


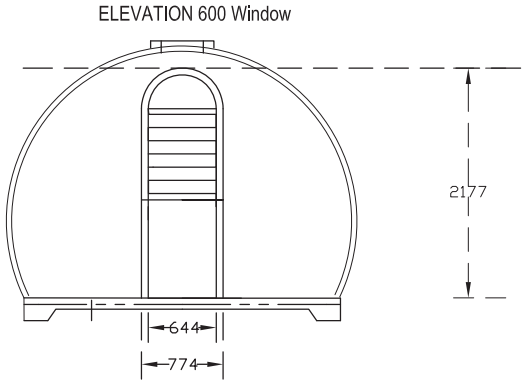


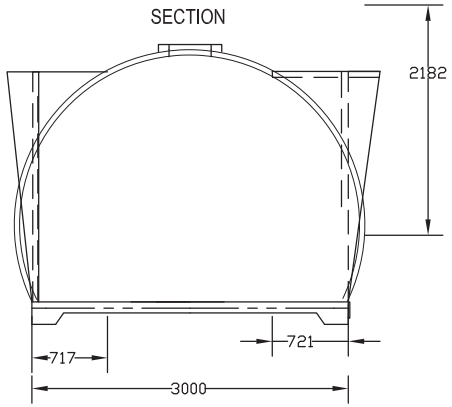


Thickness of shell 100mm (4 inches) comprised of:
a 70mm thick. structural basalt fibre rebar and mesh reinforced concrete shell
a 30mm layer of lightweight thermal concrete (perlite, scoria, air-crete, hemp crete or other) over the top of the structural shell for thermal insulation - (note: the thickness of the thermal layer can be increased to suite conditions or preferences.

Shell structure reinforcing:
6mm basalt fibre rebar placed 150mm vertical x 150mm horizontal.
1-2 layers of 5mm basalt mesh - stretch and fix tightly to the basalt frame.







The designs contained within the set of drawings: BSLT3.0-1 to BSLT3.0-10 are to be read simultaneously with the "Basalt Dome Building Manual" and the "On Line Dome Building Workshop".
They are for educational purposes only.
The shell is designed to wind speed of 51 mps for a particular site and foundation system designed for that site.
Warranty by Domeshells extends only to an engineered certified design for a particular site and for workmanship that meets Domeshells and industry professional standards.

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References

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3.0m Basalt Fibre Reinforced Dome
Plan, Elevations Sections
For Training and Education Purposes

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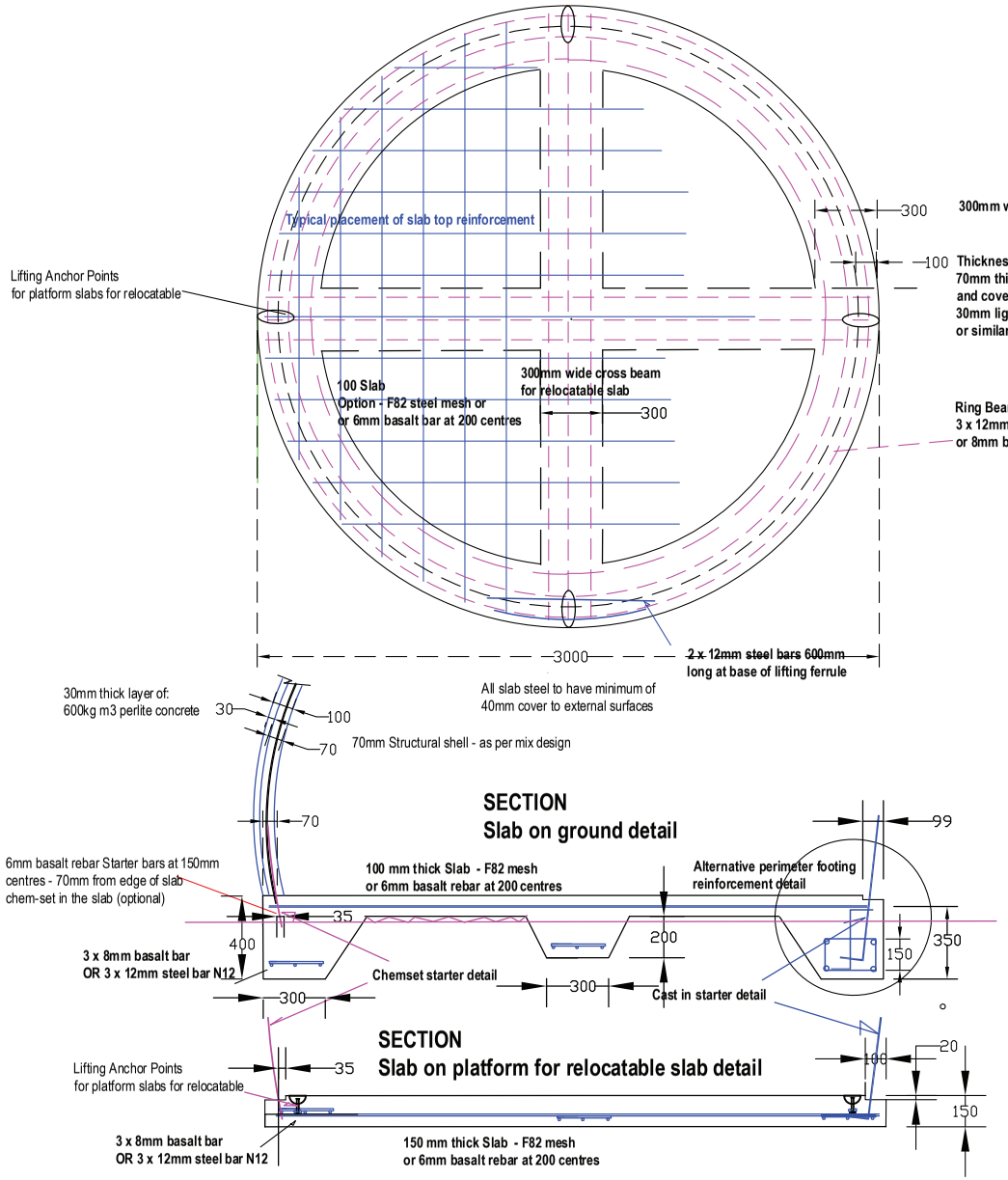
BSLT3.0-1
REV.

Slab and Footings reinforcement for in ground slab and relocatable slab



NOTE:
The slab and footing detail contained in this drawing is a nominal design for certain conditions and does not take into account design for your particular soil type and wind and seismic zone .

Certain locations and circumstances may require a different design

Options for reinforcing bars for footings and slab:
may be reinforced the conventional way with steel
may be reinforced with basalt rebar.
Ensure minimum 40mm cover over steel and minimum of 25mm cover over basalt

The designs contained within the set of drawings: BSLT3.0-1 to BSLT3.0-10 are to be read simultaneously with the "Basalt Dome Building Manual" and the "On Line Dome Building Workshop".
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dome shells

References

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3.0m Diameter -
Basalt Reinforced Concrete Dome
Footing & Slab Details
and options

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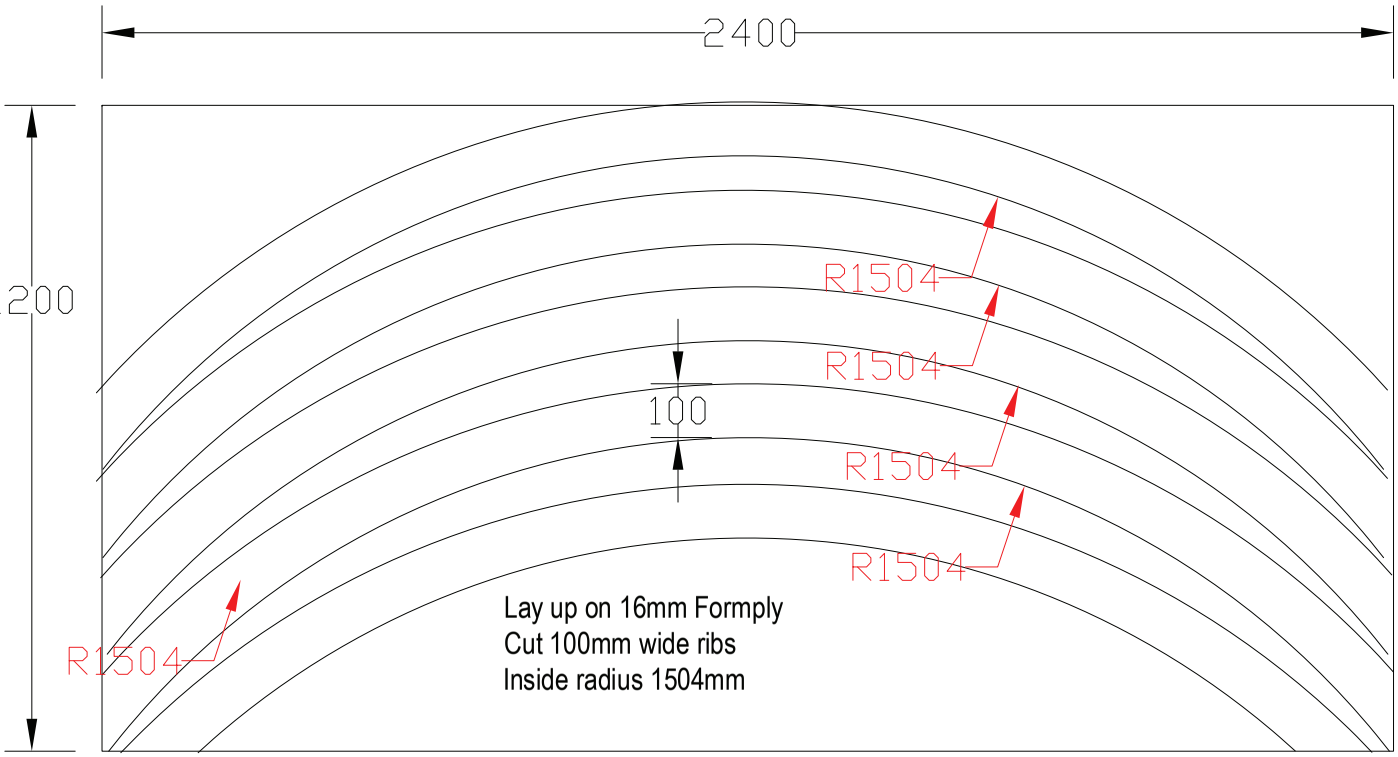
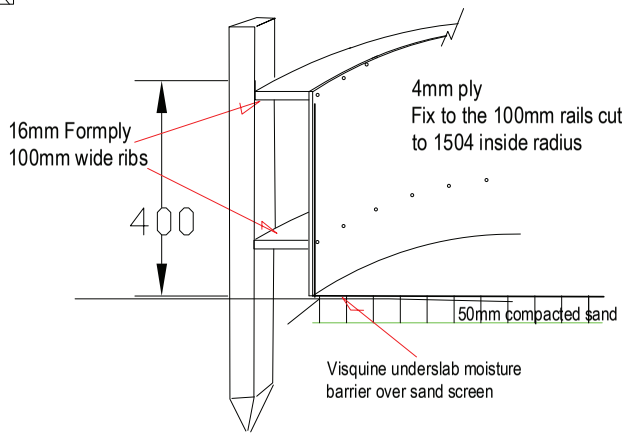


3.0m diameter Dome
Typical Slab Former Detail

The finished diameter of the slab is 3.0m
the radius is 1.5m

Use 4mm ply for the vertical edge
Use 16mm formply for the outer ribs
Cut 100mm wide ribs with inside radius of 1504mm

Typical slab form detail for a slab on ground. NOTE: the depth of the ring beam footing could be between 400mm to 600mm



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3.0m Dome
Slab Former
DETAIL

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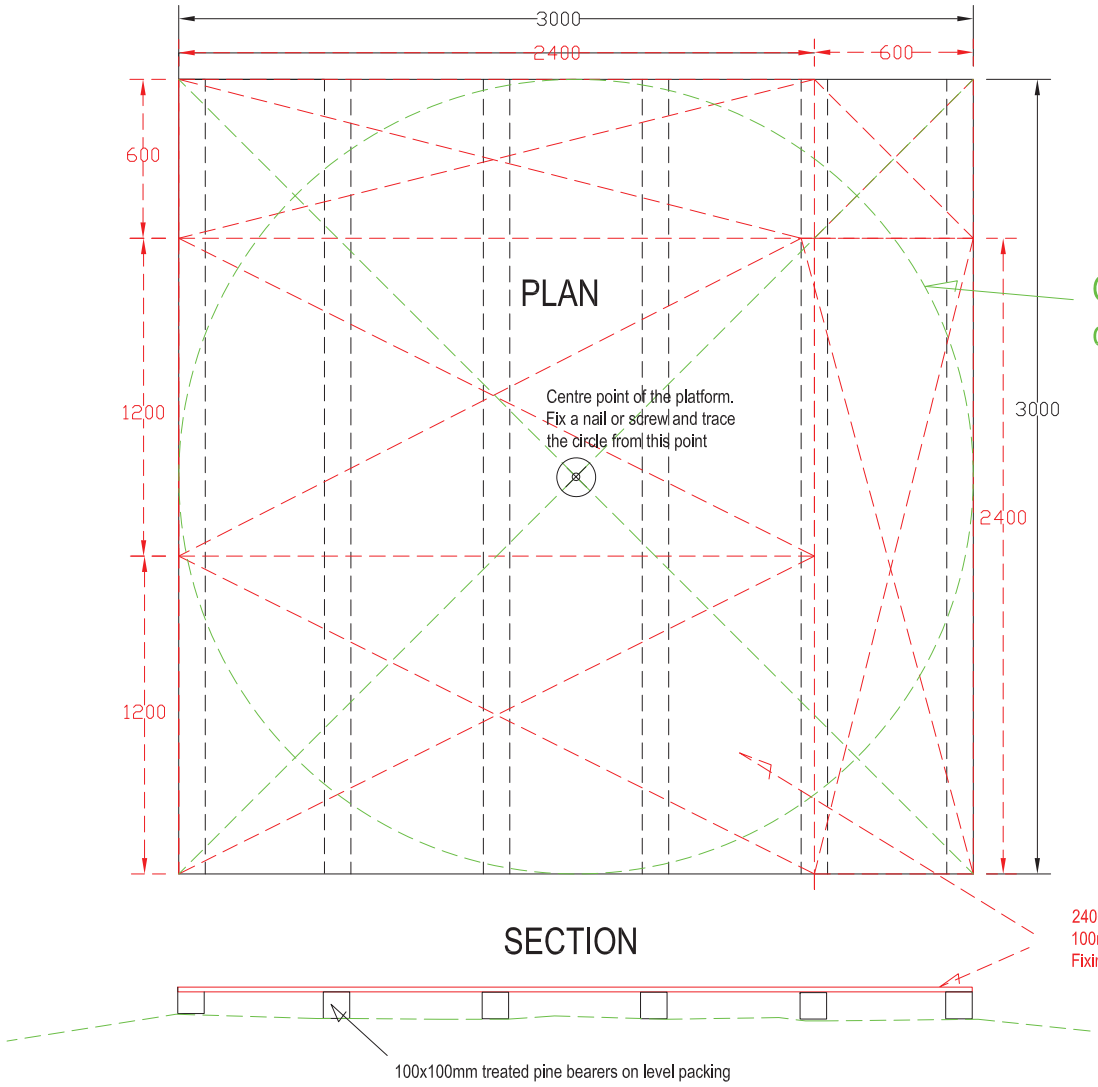

3.0m Dome Building Platform

PLAN and SECTION

3.0m x 3.0m Platform for the fabrication of a relocatble 3.0m diameter Domeshell

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3.0m Dome Building Platform Detail

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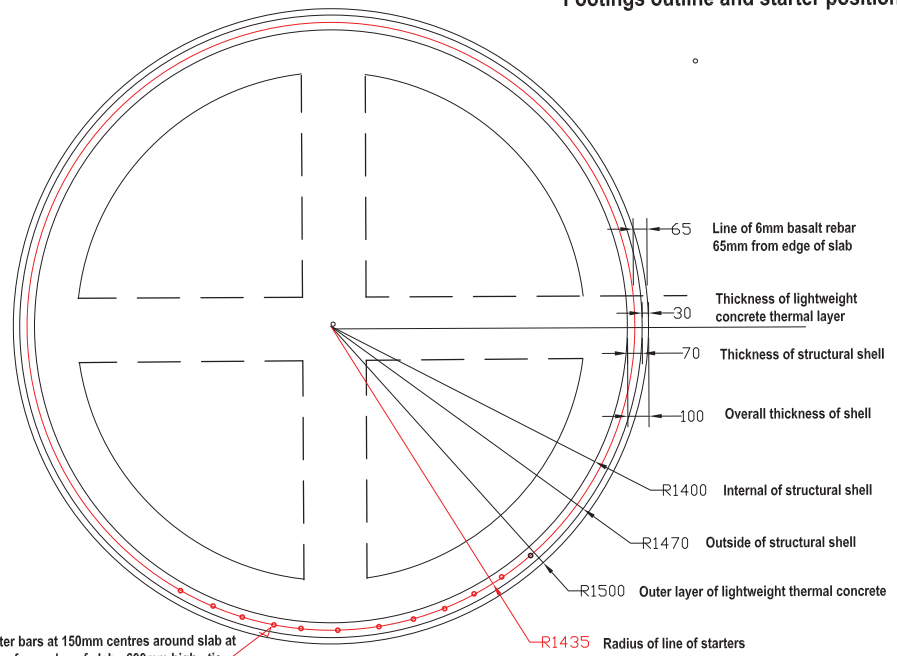
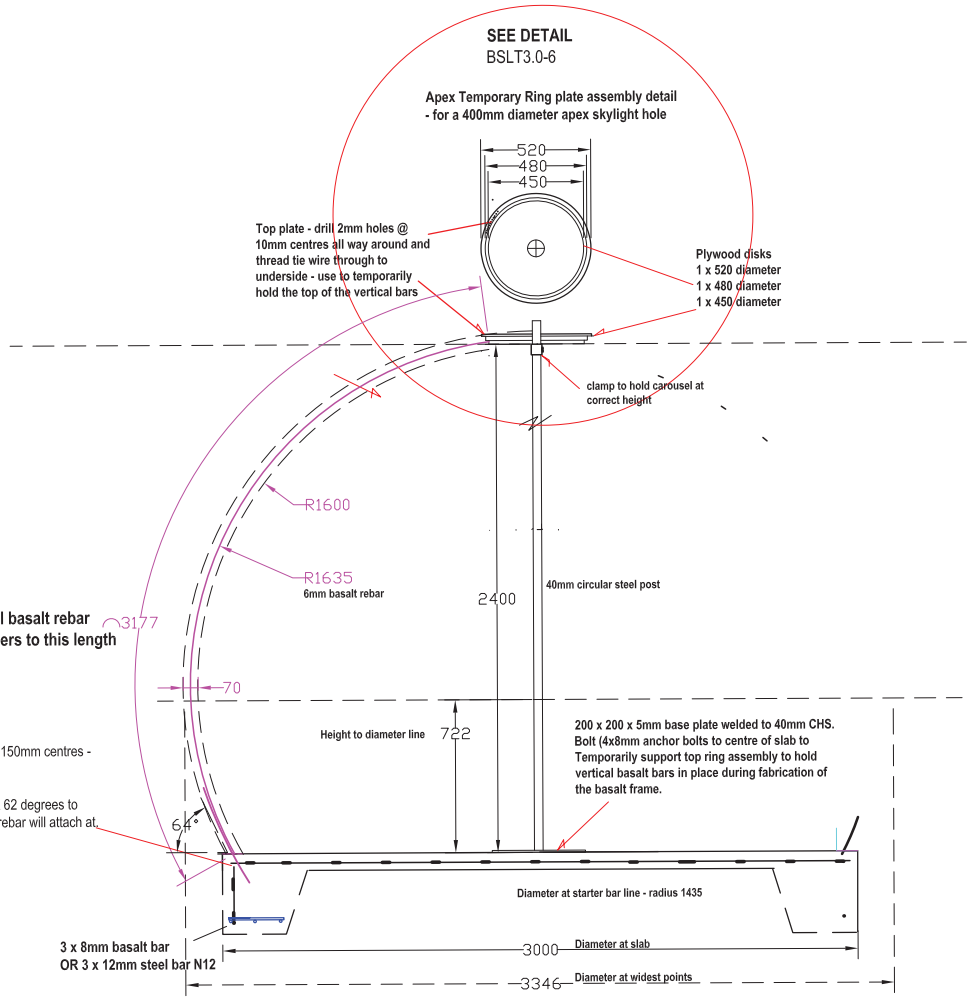
PLAN DETAIL
Footings outline and starter positions



Starter bars at 150mm centres around slab at 65mm from edge of slab - 600mm high - tie vertical bars to starters.
Ensure that the starter bars are inclined outward at the same degree the dome intersects the slab



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3.0m Diameter - Basalt Fibre Reinforced Dome Shell Vertical Bar Placement and assembly DETAIL

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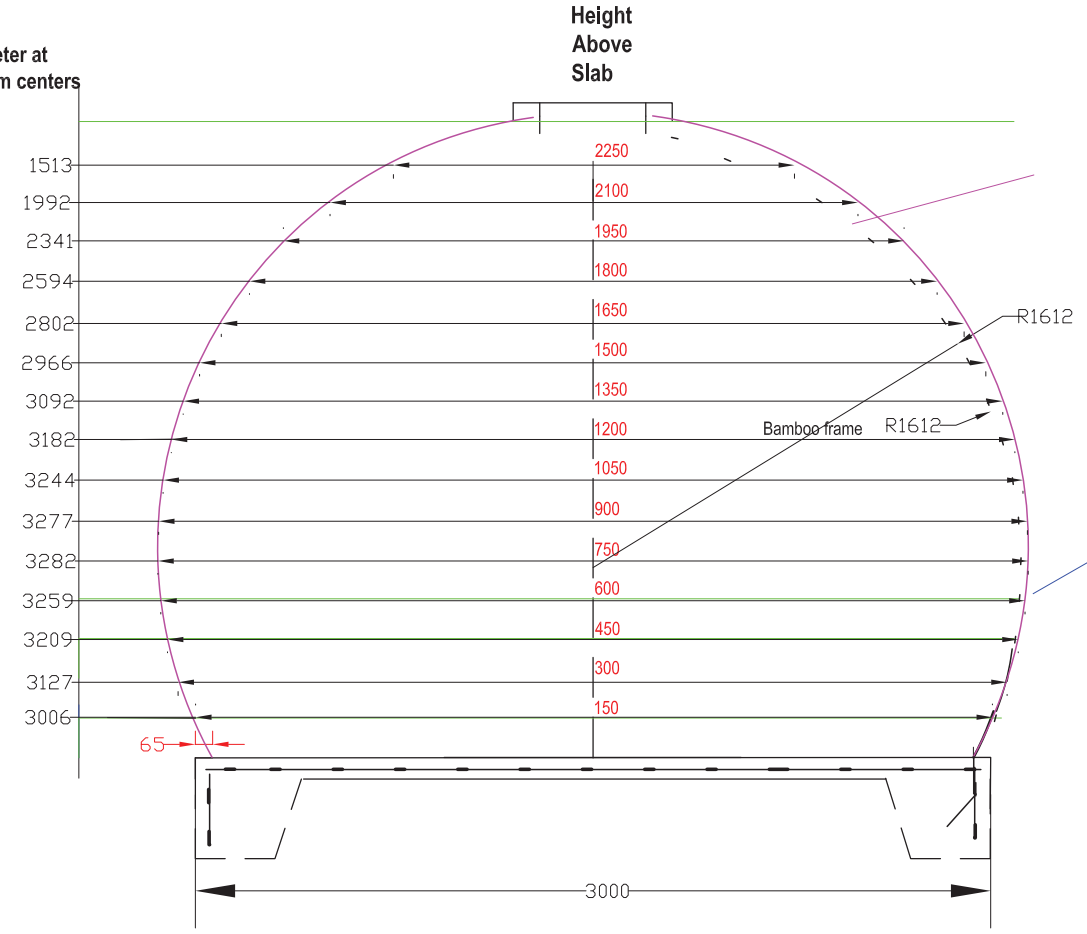
3.0m - SECTION DETAIL
Horizontal Bar measurement - circumference at 150mm centres

Circumference plus 800mm for 400mm lap at join	Circumference	Height off slab	Diameter at 150mm centers
5555	4755	2250	1513
7061	6261	2100	1992
8157	7357	1950	2341
8953	8153	1800	2594
9606	8806	1650	2802
10122	9322	1500	2966
10518	9718	1350	3092
10801	10001	1200	3182
10995	10195	1050	3244
11099	10299	900	3277
11115	10315	750	3282
11043	10243	600	3259
10885	10085	450	3209
10628	9828	300	3127
10247	9447	150	3006



Shell structure comprising:
6mm Basalt Fibre Rebar at 150 vertical x 150 horizontal.
1 x layer of 5mm basalt fibre mesh (minimum 115gsm)

Render to minimum of 30mm thick cover over the framing externally and internally - minimum overall thickness of 70mm.

Apply 30mm lightweight thermal render (perlite aggregate or similar) over the structural shell.

Render mix design for Structural render
3 fine washed river sand to 1 general purpose portland cement.
1 cup Bondcrete

For skim coat render add 2 grams 7mm basalt chopped fibre per 20kg cement
Apply by render spray machine

Starter bars in slab 600 high at 150mm centres.

Chemset 6mm diameter basalt rebar 150mm centres all way around the slab at the angle the curved dome meets the slab

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3.0m Basalt Dome
Horizontal Bar Location & Lengths
Sections DETAIL

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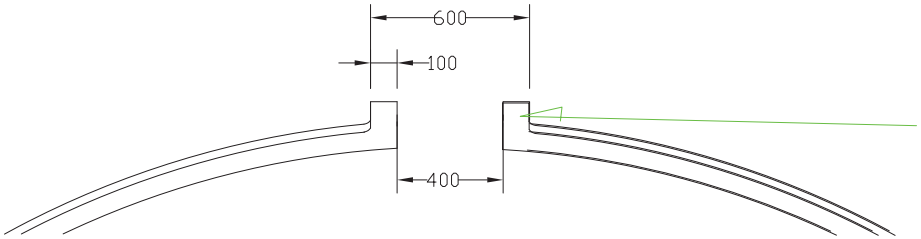
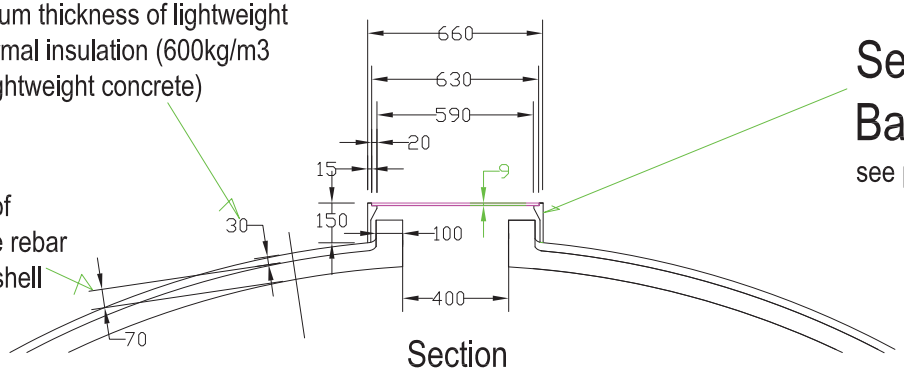
Section
Typical Apex Opening Detail



Minimum dimension of the Apex Ring
100mm wide x 70mm high above the structural shell

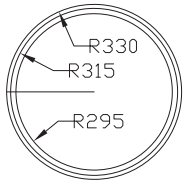
Proposed minimum thickness of lightweight concrete for thermal insulation (600kg/m3 density perlite lightweight concrete)

Minimum thickness of structural basalt fibre rebar reinforced concrete shell



Section
Basalt fibre reinforced concrete skylight
see prefabricated elements

Section
Skylight Mould Parts



Plan
Skylight mould discs
see: DETAIL BSLT3.0-7

Typical Opening for Apex Skylight NOTE: Dimension of opening size may be determined by the "owner builder". It must however, be in compliance with the structural design required for the local conditions and authorities. Engineering certification is available from Domeshells when/if required

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References

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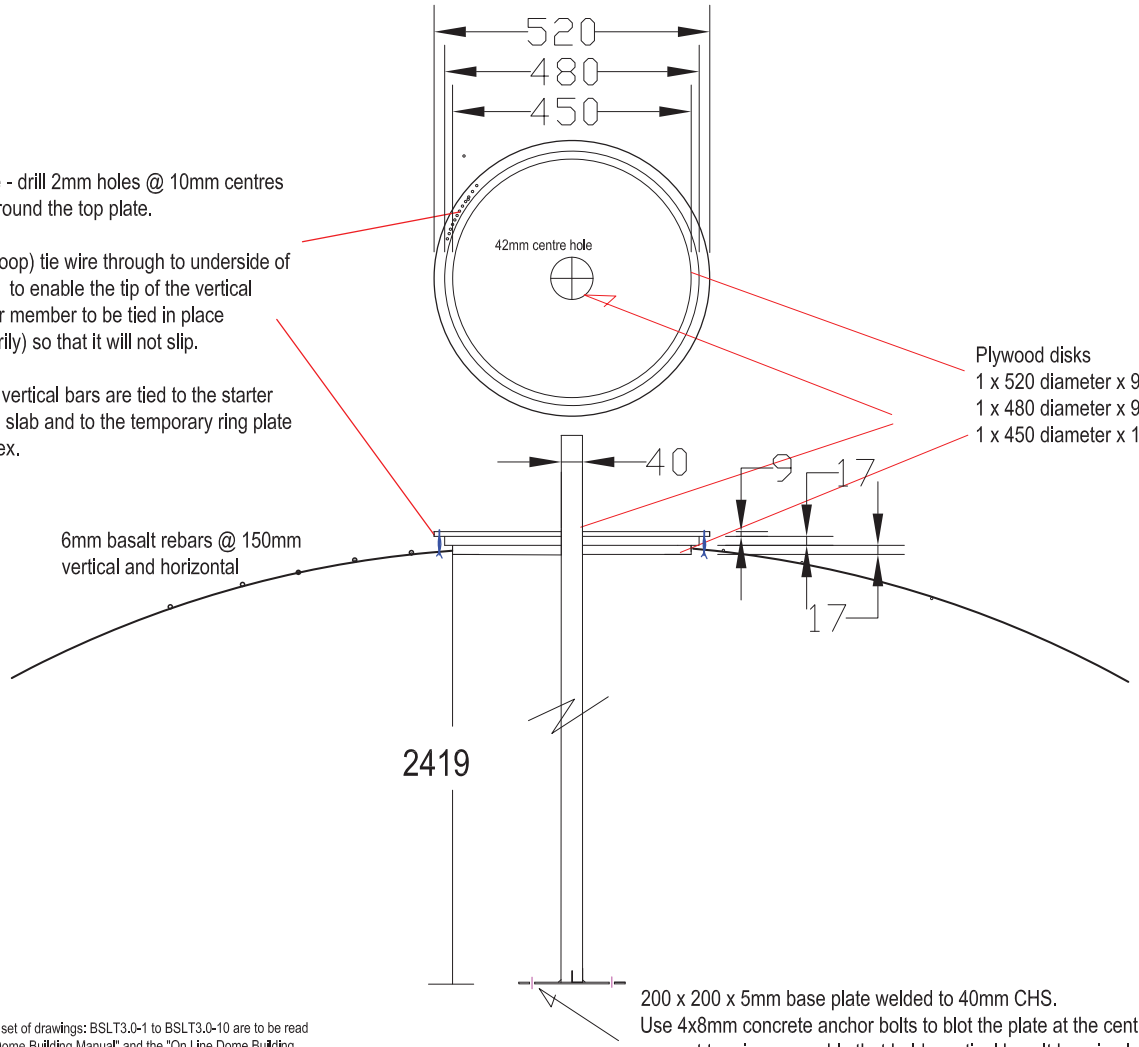
400mm Apex Opening and Skylight Sections DETAIL

Sheet - of-
A3 -Scale 1:20
Dwg: BSLT3.0-5
REV.

The Carousel Apex Temporary Ring plate assembly detail - for a 400mm diameter apex skylight hole



Top plate - drill 2mm holes @ 10mm centres all way around the top plate.

Thread (loop) tie wire through to underside of the disk - to enable the tip of the vertical basalt bar member to be tied in place (temporarily) so that it will not slip.

All of the vertical bars are tied to the starter bar in the slab and to the temporary ring plate at the apex.

Plywood disks
1 x 520 diameter x 9mm ply
1 x 480 diameter x 9mm ply
1 x 450 diameter x 17mm ply

6mm basalt rebars @ 150mm vertical and horizontal

200 x 200 x 5mm base plate welded to 40mm CHS.
Use 4x8mm concrete anchor bolts to blot the plate at the centre of the slab to support top ring assembly that holds vertical basalt bars in place during the rendering process.

The pole and carousel assembly acts to temporarily hold the vertical basalt bars in place until the shell is sufficiently rendered to within 50mm around the perimeter of the carousel.

At this point it can be removed and the pre-cast skylight ring is placed in position and rendered into the shell

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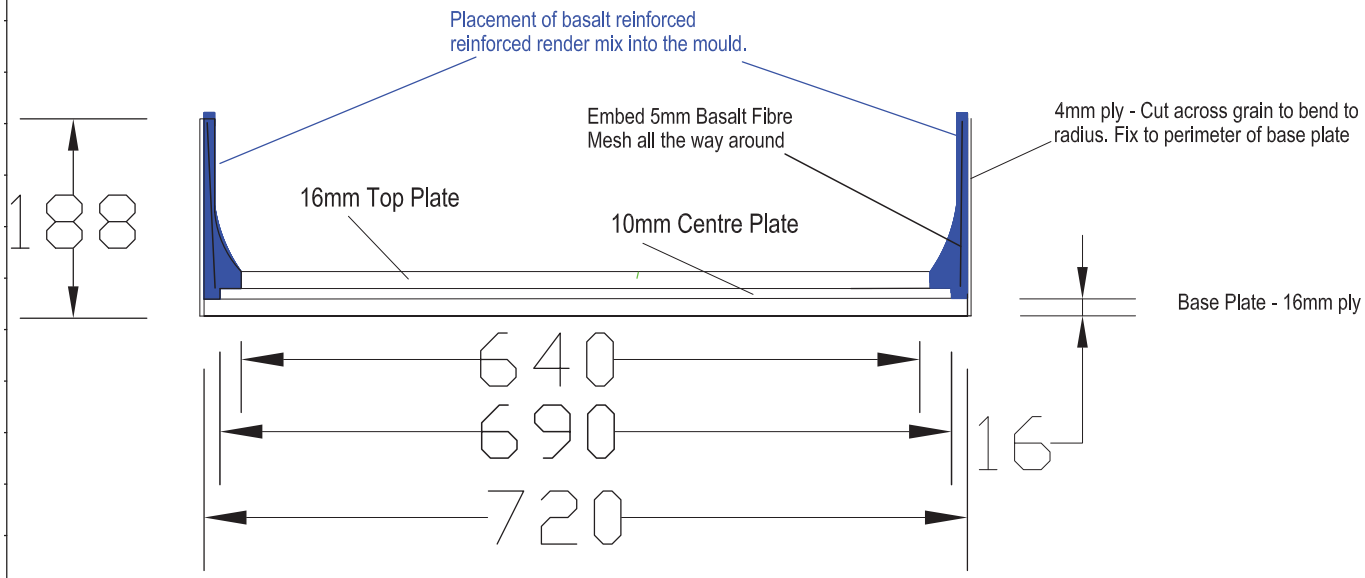
3.0m Dome
Temporary Pole and Plywood Disk Ring Assembly
The Carousel
DETAIL

Sheet - of-
A3 -Scale 1:10
DWG:
BSLT3.0-6
REV.

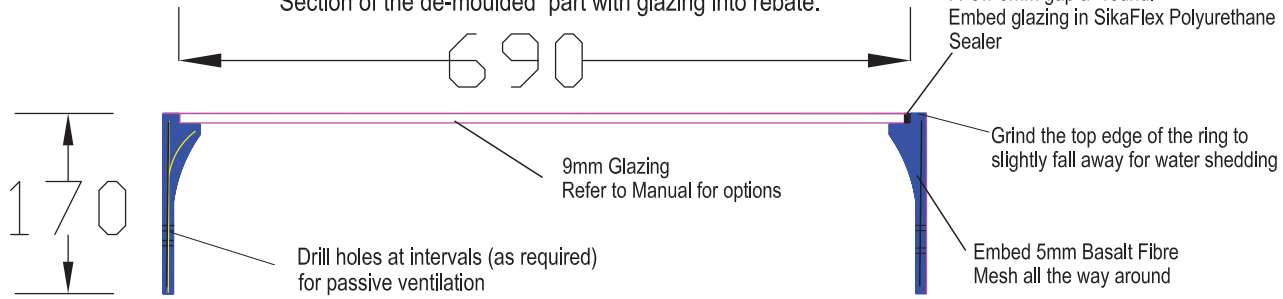
Section

Section of Mould Assembly for the Fabrication of a Basalt Fibre Mesh and Chopped Fibre Reinforced Concrete Skylight.



Section

Section of the de-moulded part with glazing into rebate.



Section
Skylight Mold Fabrication Detail

Mix Design:

2:1 fine sand to portland cement

.4 water *(water to be premixed $\frac{50}{50}$ with SEBR Polymer or Bondcrete)*

7mm basalt fibre - 2 grams

Set depth of glazing rebate in the mould to suite the thickness of the glass to be installed. Allow 5mm of clear space all way round the ring for adequate water sealing - Install glazing in a full bed of SIKAFLEX Polyurethane Sealer/Adhesive or similar quality polyurethane sealer.

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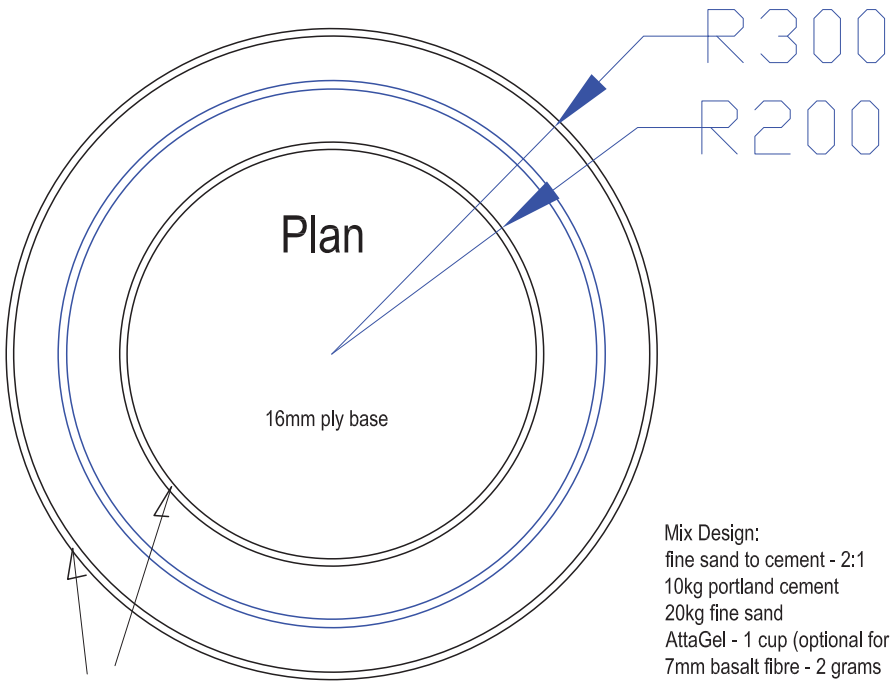
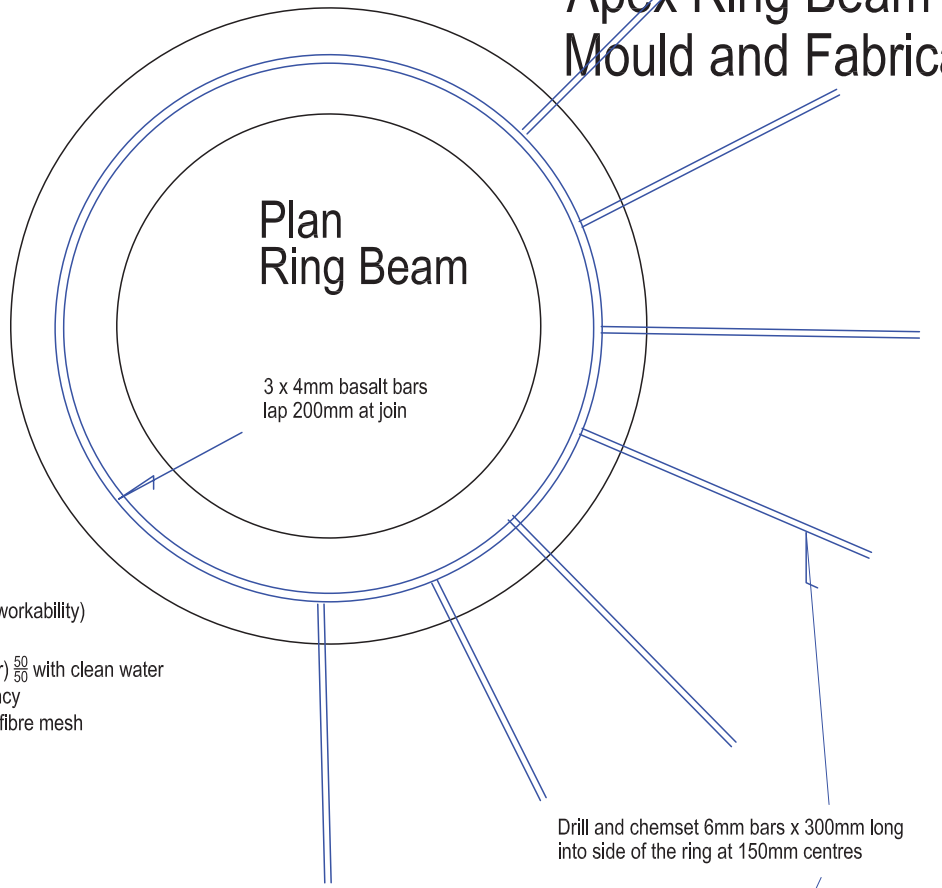
Skylight Ring Mould & Fabrication DETAIL

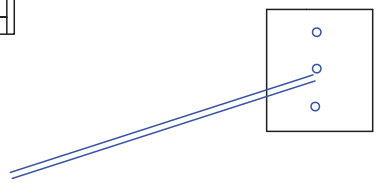
Sheet - of -
A3 -Scale 1:5
DRG. BSLT3.0-7
REV.

Apex Ring Beam Mould and Fabrication.

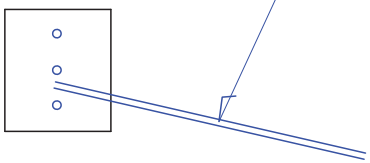


Mix Design:
fine sand to cement - 2:1
10kg portland cement
20kg fine sand
AttaGel - 1 cup (optional for workability)
7mm basalt fibre - 2 grams
Bondcrete (or similar polymer) $\frac{50}{50}$ with clean water
Mix to a stiff pliable consistency
Lay in 1 layer of 5mm basalt fibre mesh





Section
Ring Beam



The designs contained within the set of drawings: BSLT3.0-1 to BSLT3.0-10 are to be read simultaneously with the "Basalt Dome Building Manual" and the "On Line Dome Building Workshop". They are for educational purposes only.
The shell is designed to wind speed of 51 mps for a particular site and foundation system designed for that site.
Warranty by Domeshells extends only to an engineered certified design for a particular site and for workmanship that meets Domeshells and industry professional standards.

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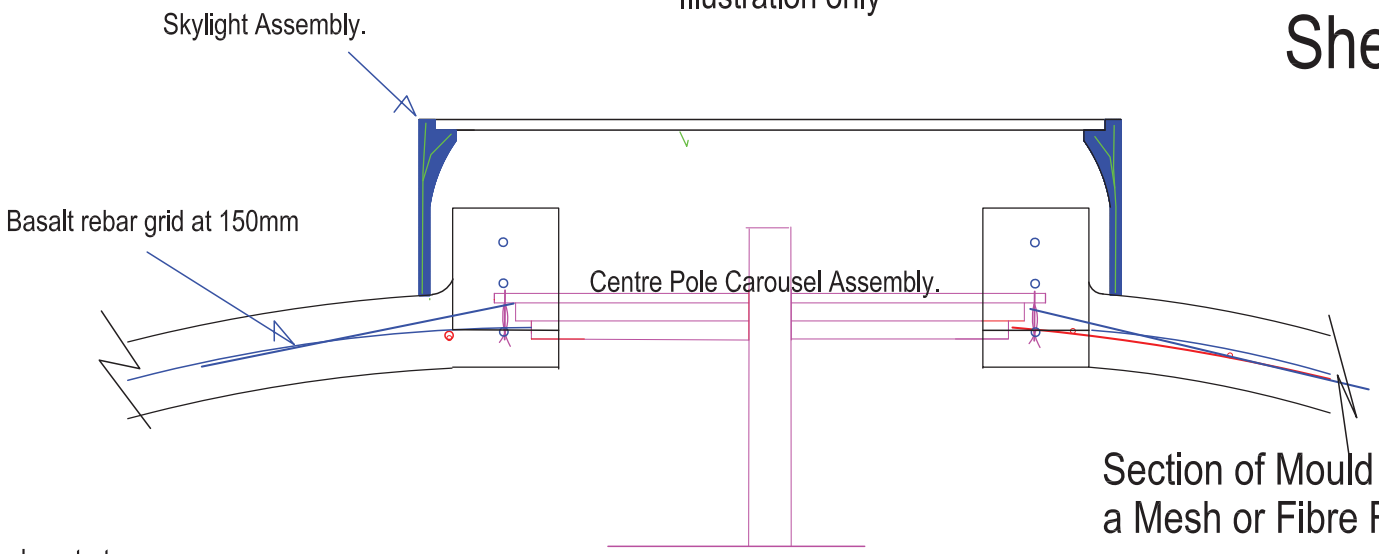
Apex Ring Beam Mold & Fabrication DETAIL

Sheet - of-
A3 -Scale 1:5
DRG. BSLT3.0-8
REV.

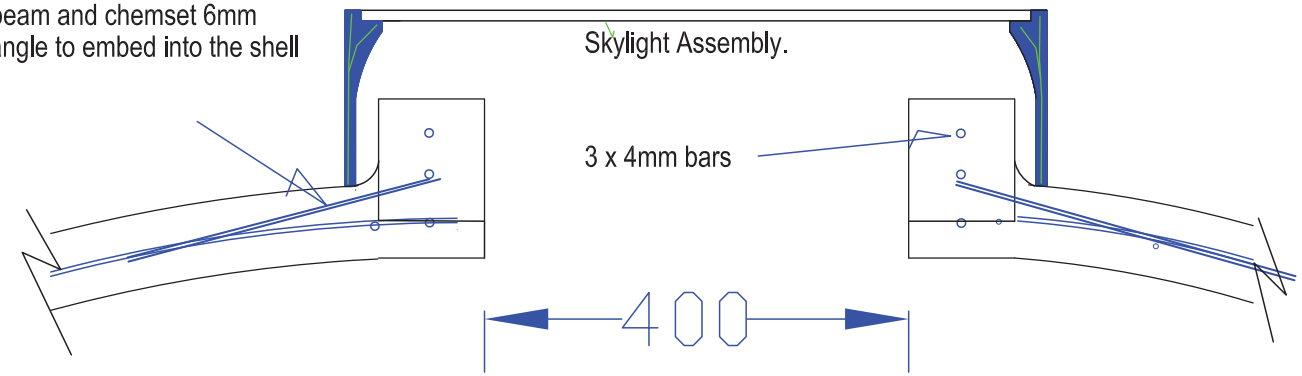
Apex Ring Beam to Shell Wall Connection

Not to scale
Illustration only



Section of Mould Assembly for the Fabrication of a Mesh or Fibre Reinforced Concrete Skylight.

Basalt rebar starters
Drill into ring beam and chemset 6mm basalt bar at angle to embed into the shell



The designs contained within the set of drawings: BSLT3.0-1 to BSLT3.0-10 are to be read simultaneously with the "Basalt Dome Building Manual" and the "On Line Dome Building Workshop". They are for educational purposes only.
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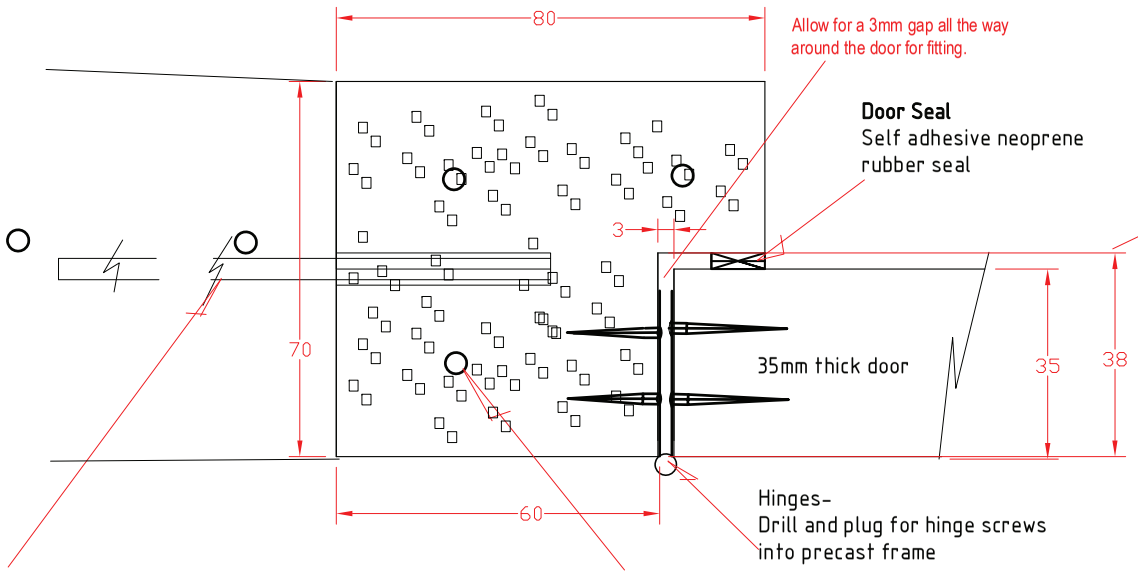
Apex Ring Beam to Shell Wall Connection DETAIL

Sheet - of-
A3 -Scale 1:5
DRG. BSLT3.0-9
REV.

SECTION through
vertical jamb/frame



Dowell - 4mm Basalt Bar Starters x 100mm long.
Drill 5mm hole at 300mm centres all way around the frame - insert 4mm basalt bar to cast into shell wall and chemset in place.
Ensure the holes are blown out to remove ALL dust.

SECTION:
Precast Basalt Fibre Reinforced Concrete Door and WIndow Frames

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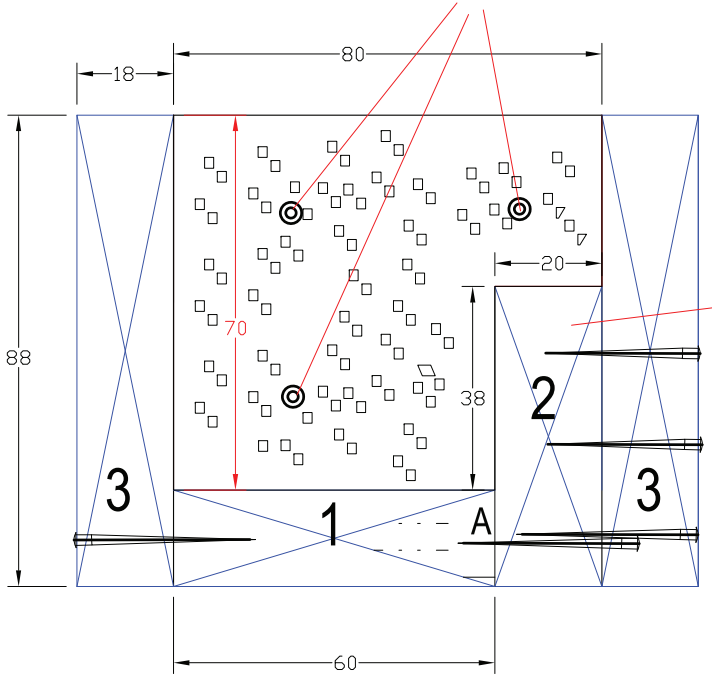
Section:
PreCast Door and Window Jamb

Sheet - of -
A3 - 380x230 - Scale 1:1
DRG. No.
BSLT3.0-9.1
REV.

The drawing assumes a formply
thickness of 18mm - It could be 16mm

SECTION:
Mould Profile for Precast Basalt Fibre Reinforced Concrete Door and WIndow Frames

Reinforce with:
3 x continuous 4mm basalt fibre rebar.

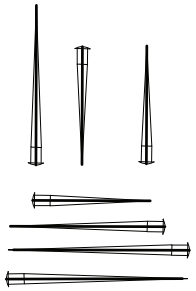


LEGEND

Formply

Basalt reinforced render

This piece forms the block-out for the door jamb. Here we have allowed for a 20mm deep rebate to the jamb and a door thickness of 35mm + 3mm - (total 38mm)
Adjust width to suite the actual dimensions of window or door you have.



1 This is the first part of the mould to cut.
The **A** side will be on the line traced of the outside of the door plus 3mm

2 This is the second part of the mould to cut.
Fix part 2 to part one. The height extending above part 1 is equal to the door thickness plus 3mm

3 Parts 3 form the sides of the mould to give it a height of 70mm

Mix Design for all the Prefabricated Elements

Use a higher strength mix:

1 cement
2 sand
.4 water
50% of the liquid is an SBR polymer or similar (Bondcrete)
Mix the water and polymer together and stir thoroughly before use
200grms of basalt chopped fibre

Mixing Order

1/. Mix the water and polymer before hand
2/.Thoroughly mix the sand, cement and water/polymer to its full consistency.
3/. Add the fibre by slowly sprinkling in the mix.
4/. Allow the fibre to mix for 3-5 minutes before using.
DO NOT OVER MIX TO AVOID FIR BALLING THE FIBRE

REV	DATE	BY	DESCRIPTION	GRID REF	CHECKED	APPROVED

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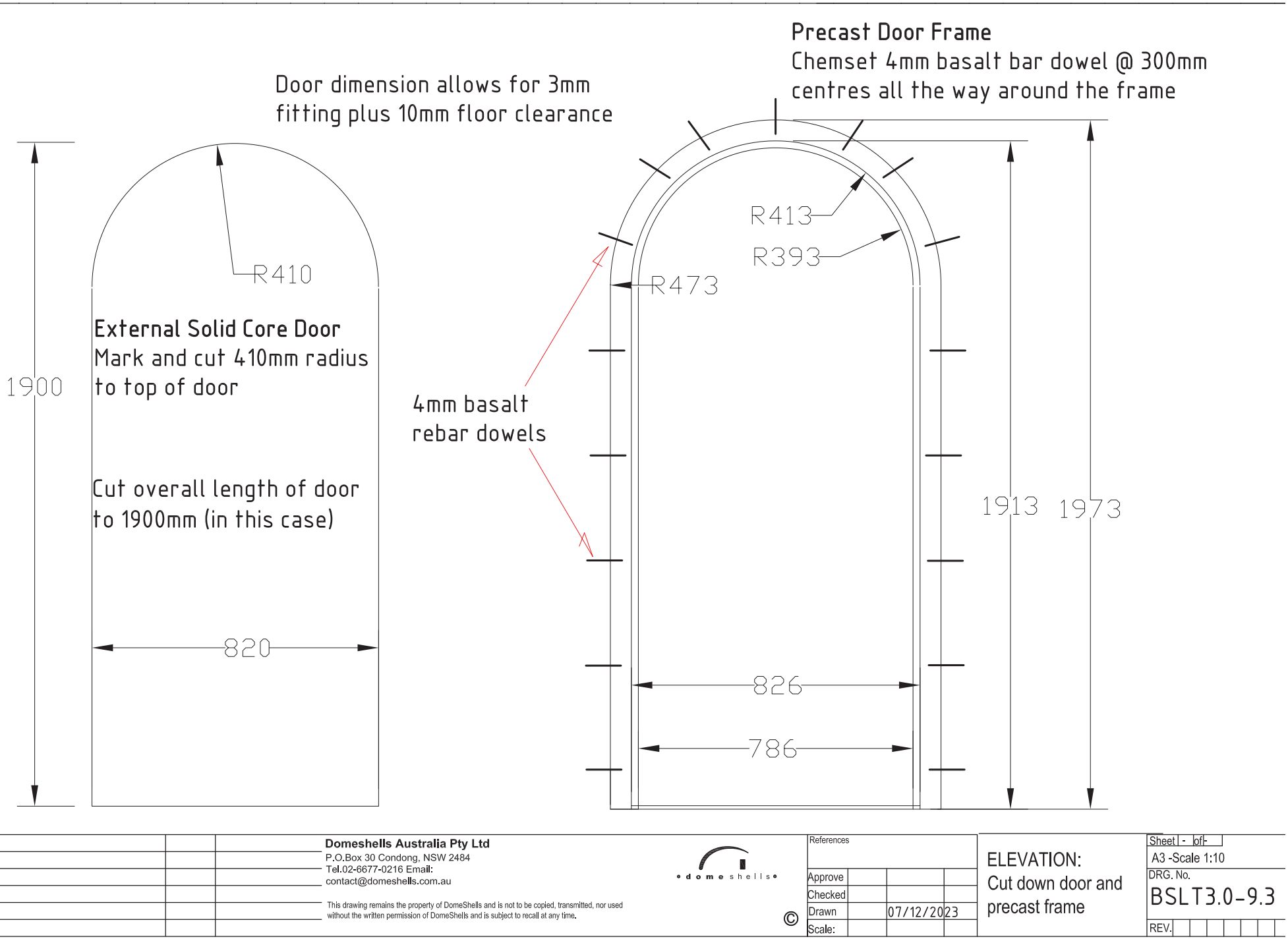
Section:
MOULD
PreCast Door and
Window Jamb

Sheet 1 - of -
A3 - 380x230 - Scale 1:1
DRG. No.
BSLT3.0-9.2
REV.



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Scale:			

ELEVATION:
Cut down door and precast frame

Sheet - of-
A3 -Scale 1:10
DRG. No.
BSLT3.0-9.3
REV.

NOTES

MATERIAL QUANTITIES
Quantities for the Construction of a 3.0m dia. Dome

Construction Material Quantities for 3.0m Domeshell

Pi = π = 22 divided by 7 = 3.14285714285714 - We will use the number 3.14

Formulas

Area - Circle $A = \pi r^2$	7.07	m2
Area of Sphere $A = 4\pi r^2$ or Therefore Dome Surface area (hemisphere) plus .750 x circumference	21.22	m2
Dome surface area plus 20% - for conc. Calculations	25.00	m2
Circumference = C= $2\pi r$	9.43	lm

NOTE: Cost prices shown are for NSW Australia dated 12 April 2022 and may not be relevant to your area

Description	Qty	Unit	Price	Total	TOTAL
Concrete SLAB					
Slab former materials					
Slab Former Pegs (25 x50 x 600 - pack of 12)	1.00	of	$ 30.00	$ 30.00	
Slab Former 7mm ply at 400mm wide - (sheets 2400x1200)	2.00	sheets	$ 37.00	$ 74.00	
Sand - Under slab Sand 50mm thick	0.35	m3	$ 90.00	$ 31.82	
Under slab waterproofing - Polyurethane 200um - 200mm overlap	14.14	m2	$ 4.00	$ 56.57	
Duct Tape - roll	1.00	rolls	$ 8.00	$ 8.00	
Tie wire - bundle	1.00	packet	$ 6.00	$ 6.00	
Plastic bar chairs Pk100 40mm	1.00	allow	$ 25.00	$ 25.00	
Slab Steel					
Footings - Ring Beam & cross beams 3 x 12mm bar	8.00	lengths	$ 13.00	$ 104.00	
Slab Mesh F820 (8mm @ 200x200) - sheet 6000x2400 (14.4m2)	1.00	sheets	$ 90.00	$ 90.00	
Tie Wire - cut bundle	1.00	coil	$ 6.00	$ 6.00	
Concrete					
Concrete ring beam = Allow 300mm x 400mm	1.13	m3			
Concret Slab - allow 100mm	0.71	m3			
Total Concrete - 32mpa 10mm agregate	**1.84**	m3	**$ 300.00**	**$ 551.57**	
Total Formwork, steel and concrete materials				**$ 982.96**	
Labour estimate - Forming, plastic sheet, steel, starters, pour and finish concrete -	24.00	hrs		$ -	
Total SLAB FORM & SLAB MATERIAL COSTS				**$ 982.96**	**$ 982.96**

BASALT FIBRE MESH, REBAR & CHOPPED FIBRE

Number of lineal metres per square metre for 150mm grid	*16.00*				
Footing - 10mm basalt bar (optional)	33.00	lm	$ 3.40	$ 112.20	
				$ -	
Dome Slab				$ -	
Basalt Rebar				$ -	
Starters - 6mm basalt bar @ 150mm centres x 800mm	44.00	lm		$ -	
Vertcial &Horizontal Basalt Bars @ 150mm centers -	339.45	lm		$ -	
1m2 dome surface = 13.3lm/m2 +15% =16m/m2				$ -	
Total Qty of 6mm basalt rebar	**383.45**	lm	$ 1.90	$ 728.55	
				$ -	
4mm Basalt Bars	30.00	lm	$ 1.20	$ 36.00	

7MM Chopped Basalt fibre	10.00	kg	$ 11.98	$ 119.80		
Basalt Mesh 5mm x 5 mm flexible basalt mesh	30.00	m2	$ 3.65	$ 109.50		
Basalt Mesh 25mm x 25 mm flexible basalt mesh	5.00	m2	$ 12.80	$ 64.00		
Total cost of Basalt Fibre materials				**$ 1,170.05**		
Labour estimate fix reinforcing bars	40.00	hrs	$ -	$ -		
Total All BASALT Material and Labour - Retail Cost				**$ 1,170.05**	**$**	**1,170.05**

Shell Structural Render/Concrete 70mm thick

Total Area = F6 x.07 Plus 20% = 26m2 x .07 +.16						
Concrete for structural shell - Quantity	**1.98**	**m3**				
Sand - allow for minimum of 1.5m3 fine washed sand (river sand can also be used)	1.50	m3	$ 100.00	$ 150.00		
Portland cement - 20 kg bags	55.00	bags	$ 8.00	$ 440.00		
Polymer additive - Bondcrete or similar - 20kg containers	8.00	of	$ 80.00	$ 640.00		
Total Shell Structure concrete materials				**$ 1,230.00**		
Labour estimate - Apply by hand and Spray (Rendersprayer machine)	150.00	hrs		$ -		
Total - Shell Concrete Materials & Labour				**$ 1,230.00**	**$**	**1,230.00**

Perlite Insulation layer - 30mm thick

Perlite - Volume - .9m3 - allow 5 x 100lit bags	5.00	bags	$ 40.00	$ 200.00		
Attagel	2.00	bags	$ 90.00	$ 180.00		
Cement - Portland cement	20.00	bags	$ 8.00	$ 160.00		
Total Perlite and cement materials				**$ 540.00**		
Labour estimate	80.00	hrs		$ -		
Total Perlite & Labour				**$ 540.00**	**$**	**540.00**

Prefabricate Doors Windows Skylight Frames

Plywood materials for fabricating the moulds	1.00	allow	$ 500.00	$ 500.00		
Skylight 700mm diameter x 9mm thick polycarbonate	1.00	allow	$ 150.00	$ 150.00		
Window - use a recycled window you can get for less than $100	1.00	of	$ 100.00	$ 100.00		
Door - use a 2040 x 820 wide external solid core door	1.00	allow	$ 350.00	$ 350.00		
Total cost of door window and skylight mould materials				**$ 1,100.00**		
Labour estimate	**32.00**	hrs	$ -	$ -		
Total Materials Cost for Prefabricating Moulds				**$ 1,100.00**	**$**	**1,100.00**

Total Estimated Cost of Materials Only	**$ 5,023.01**

TOOLS REQUIRED

Concrete mixer.
Sure you can mix it in a barrow by hand but it's a lot easier with just a 60lit mixer

Trowels
There is quite an assortment of trowels in the bucket and you will need all of them.
They range from small pointing trowels to plasterers' trowels, concreting trowels, swimming pool trowels.
Note, scrubbing brushes for cleaning, sponges for sponge finishing the render and gloves to help keep you hands in good nick.

Render Spray Machines
These simple machines are the best thing for getting material on the wall and they speed construction time. There are two types here.
One is a straight wall sprayer and the other is a "combo"designed for spraying overhead or on the ceiling.
If you were to get only one of these we recommend the "COMBO"
To purchase one of these machines visit:
https://rendersprayer.com.au
https://domeshells.com.au

Air Compressor
The compressor supplies air to the spray machines.
The compressor on the left supplies air at 240lit per minute which is about the minimum to power the sprayers.

More air volume is always better

Power and Other Tools
Building the dome requires only a few tools:
power saw, jigsaw, handsaw
drills, hammer drill, angle grinder
bolt cutter, side cutters, end cutters
stools, ladders, platforms
10 lit buckets, large mixing buckets
shovels, spades

List of Hand Tools

We have witnessed people building concrete domes with less tools than listed below. In fact it is possible to build a concrete Domeshells even without electricity using non electric hand tools only.

Due to the varying types of tasks it is preferable to have access to the following hand tools

- power saw
- jigsaw
- handsaw
- plane
- level
- hammer
- square
- string line
- drill/driver
- hammer drill
- angle grinder with steel blade and diamond blade
- bolt cutters
- end cutters (for tying steel)
- cement mixer (electric or petrol)
- wheelbarrow
- shovels
- trowels - a range of renderers trowels (enough for at least 5 workers)
- 10 lit buckets x 10
- large wide plastic 30-40lit buckets x 4
- step ladder
- working platforms extendable to 1.0m high

Location Orientation Site Preparation and Set Out

It may be obvious to many of you however, There are some important issues to consider such as:

- LOCATION - Access – is it easy to access for trucks, turn around and delivery
- SUITABILITY - Is the area well drained? Does the land flood?
- STABILITY – Is the ground geologically stable
- ORIENTATION - How will your structure be oriented to the rising and setting sun
- WINDOWS & DOORS - Where will the front door and the windows be oriented?
- PLANT & MACHINERY - Is there sufficient area for a concrete mixer & materials

These are the initial important issues that you must satisfy for yourself.

Planning - Materials Labour & Logistics

The success of any building project is dependent on good planning. You could call it “Project Management”.

Plan your project.
Identify the building site and the orientation of your structure
Ensure you have adequate access for trucks and supplies

Sit down and plan out a realistic time frame for each task
List the materials and labour resources you will need for the task
Ensure that you have allowed sufficient lead time to secure necessary resources

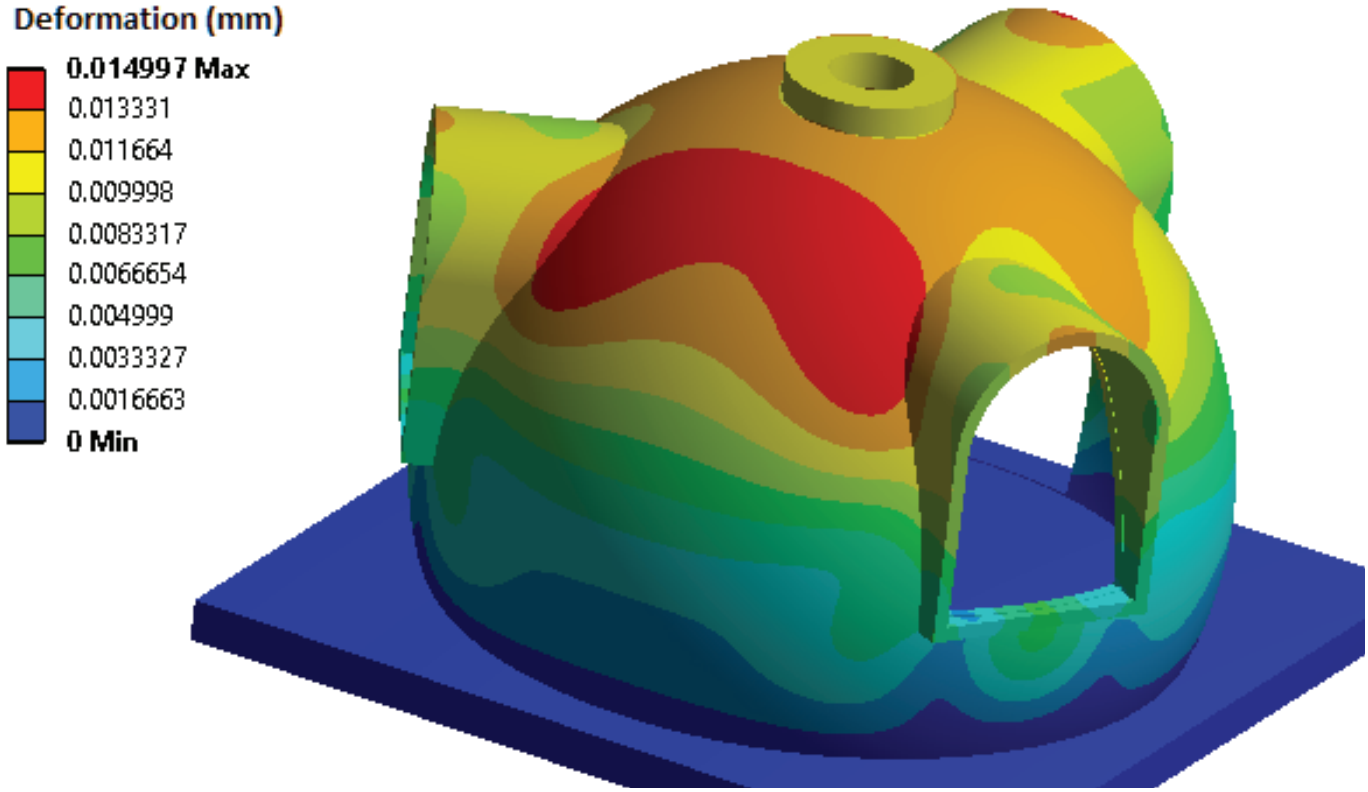
Ensure that you have sufficient skilled labour for each task.

STRUCTURAL DESIGN
USING BASALT REBAR

Domeshells is a pioneer in the use of basalt fibre building products in Australia.

Domeshells engineers have developed “Finite Element Models” (FEA) in computer simulations to establish design parameters for the structural design of basalt reinforced concrete shell structures for earthquake and up to category 5 cyclones and hurricanes.

An Example of Domeshell Finite Element Analysis (FEA)
Colour Coded Load Stress



Where to get basalt concrete reinforcing products? with a discount
Only a few countries currently manufacture Basalt fibre.
It is not manufactured in Australia.\

Domeshells is an importer and distributor of basalt building products.
We are able to supply all your basalt rebar, mesh and chopped fibre at a competitive price.

Purchasers of this manual or any of our online courses will receive a discount.

For small quantities: visit https://shop.domeshells.com.au

For your Dome Project
Get in touch at sales@domeshells.com.au
For US and other country customers we can direct you to your nearest supplier.

MATERIALS USED IN DOMESHELLS SYSTEM

Basalt fibre concrete reinforcing is the material we use for reinforcing the dome shell.
Basalt rebar is also used to some extent for reinforcing the slab.
We use basalt fibre reinforcing bar, mesh and chopped strand for reinforcing the concrete shell.

What is Basalt?
Basalt is the most common type of rock on the Planet. It is a type of igneous rock formed by the rapid cooling of lava at the surface of the earth - it's crust.

Crushed basalt rock is the only raw material required for manufacturing the fiber. It is a continuous fiber produced through igneous basalt rock melt drawing at about 1,500° C (2,700° F).

Though the temperature required to produce fibers from basalt is higher than glass, it is reported that production of fibers made from basalt requires less energy due to the uniformity of its heating.

Basalt fibres can be woven into all the same fabrics as fibre glass and carbon fibre.
The structural properties of basalt are considerably higher than glass fibre and are closer to the performance of carbon fibre

Why do we use basalt rebar?
The main reason is that it practically works so well for our method and has extremely good structural properties.

Our method of framing a "cage" in the shape of the structure using thin bars is not new. Bird cages are made the same way.

Basalt fibre bar rebar is a quarter the weight of steel and is twice the tensile strength of steel. Most importantly it behaves in just the right way that we need it.

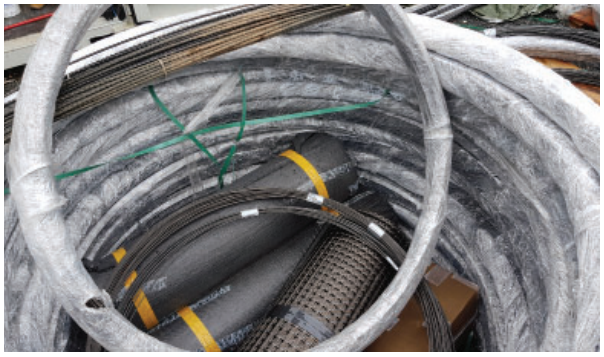
Basalt is immune to chemical attack and does not rust which guarantees against concrete cancer, a very common problem in steel reinforced concrete.

Basalt rebar should not be bent past the point of cracking in the matrix.
Ligatures and angles must be fabricated by the supplier.
Do NOT heat the bar to bend angles as it will substantially weaken the bar.

Basalt Ignatious Rock
The Raw Material

Typical Basalt Rebar

Basalt Rebar in Coils



Basalt Chopped Fibre

Basalt Mesh - 5mm x 5mm

MATERIALS USED IN DOMESHELLS SYSTEM - continued

Structural Render Mix Formula for the Shell

For the 3.0m dome and smaller domes where the render material is being applied by hand or by the "hand-held-hopper spray machine"

- **Cement -** 1 unit
- **Sand -** 3 units
- **Water -** .6 unit
- 1 cup Bondcrete (or SBR polymer)

Added Polymer improves workability of the mix and significantly improves curing of the concrete, mitigates cracking and substantially improves water-proofing.

Structural Render Mix Formula for the Pre-Fabricated Elements

For pre-fabricated elements we use a higher strength mix formula

- **Cement -** 1 unit
- **Sand -** 2 units
- **Water -** .4 unit (depending on moisture content of the sand)
-

(We highly recommend the liquid component to contain up to 50% Bondcrete or SBR polymer)

- **SBR Polymer** - up to 50% of the liquid component. Mix the polymer with the water before adding.

Added Polymer improves workability of the mix and significantly improves curing of the concrete, mitigates cracking and substantially improves water-proofing

- **7mm chopped Basalt fibre** - 2 grams per 20 kg of cement. Addition of basalt fibre increases the toughness and mitigates micro cracking.

Cement - General purpose portland cement is generally available all over the world.

Sand - for the render mix, the best sand is renderers or plasterers sand - usually a fine white washed sand.

Bondcrete or SBR Polymer - is available in many brands and can be sourced from builder suppliers or plasterer suppliers

Swimming Pool Shotcrete - For the larger domes that are sprayed using a **shotcrete spray machine** we use an aggregate size of up to 7mm.

It is important that fresh concrete retains moisture for as long as possible. Fresh concrete must be kept moist or covered to avoid rapid evaporation of the moisture.

Examples of Basic Materials Available in Australia

SBR Polymer

BondCrete Polymer

Fine White Washed Sand

General Purpose Portland Cement

CONSTRUCTION - SLABS

Footings and Slab Design Considerations for Two Slab Types

1/. A slab for a relocatble dome - built on a platform or flat level pad
What effects the design of a slab with a concrete dome attatched to it that will be lifted off its platform by a crane?

- The slab must be more substantial (thicker) and with additional reinforcing to handle the lifting stresses, transport and handling.
- **Ferrule lifting anchors** - To be lifted by a crane the slab requires lifting anchors to be cast into the slab. We prefer to cast the lifting anchors into the edge of the slab.

We cover the specifications of this type of slab on the next page

2/. A slab on ground - incorporating footings - a "raft slab"
What can effect the structural design of a footing and slab?

- ground conditions - the type or geology of the soil such as it's clay/sand/rock content and compaction
- loads on the slab including:
- gravity load of the structure, live and human loads
- wind loads
- seismic loads
- snow loads

Geotechnical Soil Report for Foundation, Footing & Slab Design
A structural engineer needs to understand the soil type at the building site to design the slab and footings accordingly. they may require a geotechnical soil report that classifies the type of soil and ground conditions. In Australia it is a prerequisite of any foundation and slab design and it required by councils.

Wind Loads
Every geographical part of the world has a wind load factor that must be taken into consideration by the engineer when designing a building. For example, some areas my be subject to cyclones, hurricanes of various categories and depending on what these are will effect the capability and design of the above ground part of the building.

Seismic loads
Earthquake is an example of a seismic load. Earthquakes have the ability to shake a building causing extreme loads on parts of the building.

In the example, we reference a generic design that may or may not be appropriate for your location.

The 3.0m diameter shell structure design and specifications presented here in this manual has been designed to category 5 wind speeds when built on a slab and foundation design specific to the location.

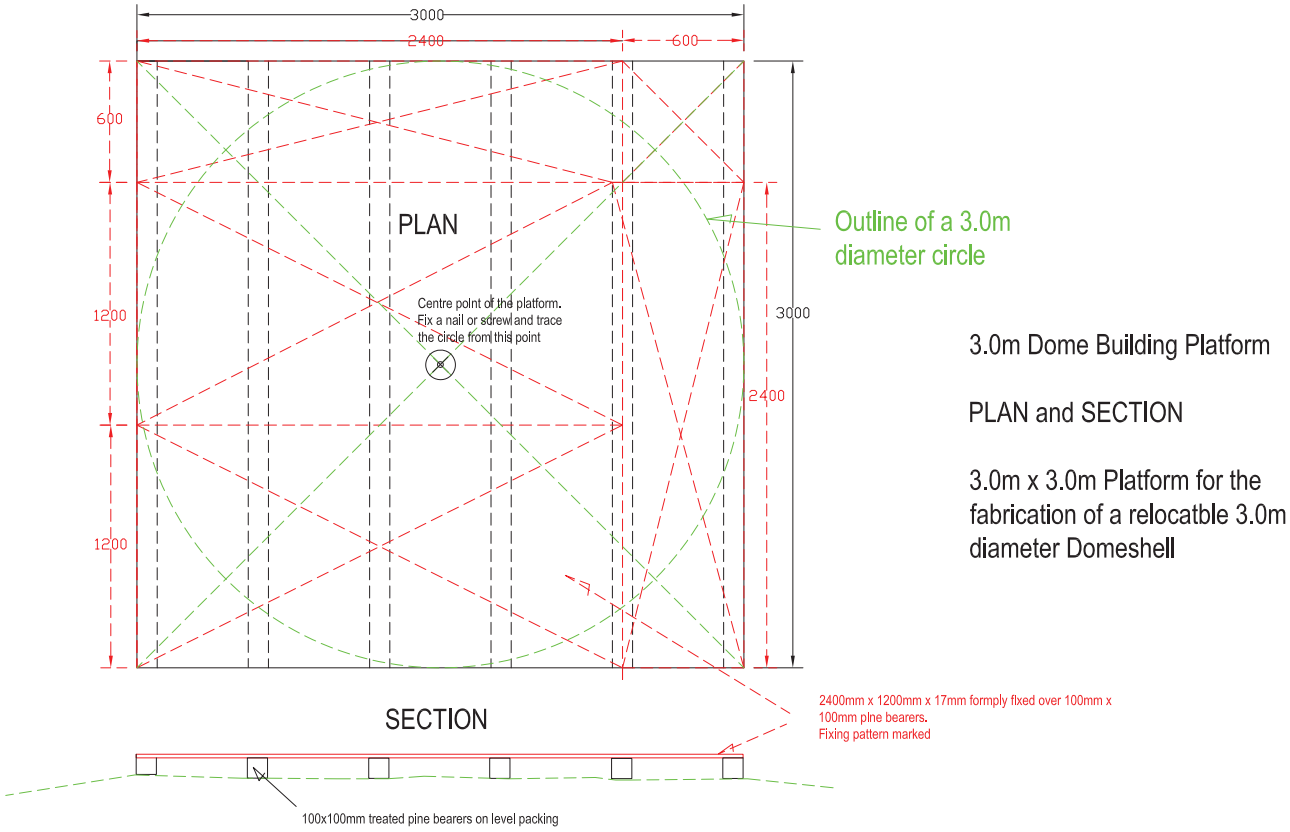
Every site and location is different. It is your responsibility to ensure compliance with local Authorities.

Reach out if you need help. We offer a full design service for anyone needing to apply for a building permit.

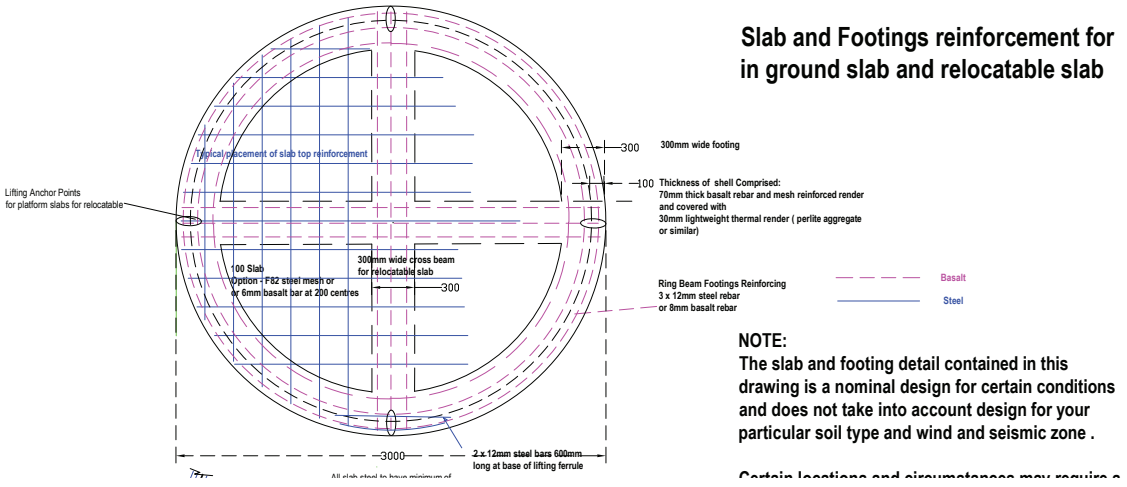
3.0m DIA. RELOCATABLE DOME SLAB

At our live workshops we build a 3.0m dome on a 16mm form ply platform.
We lay bearers at 600mm centres and fix 16mm formply to form the deck. We use formply because it is designed for use with concrete. It is sealed to prevent moisture absorption and concrete does not stick to it so easily.

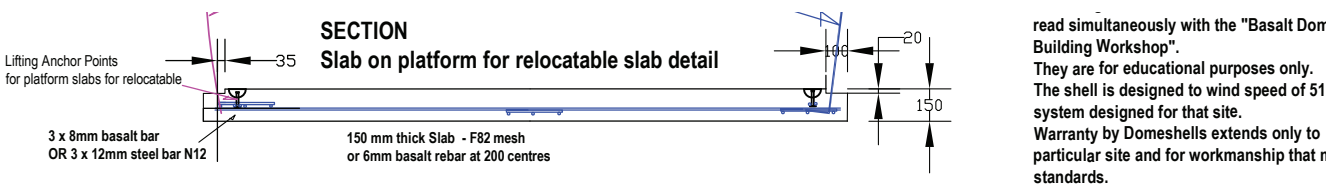
See Drawing - BSLT3.0-2b - Plan and Section of the Platform for Relocatable Dome Option



Drawing BSLT3.0-2 Plan - The Slab layout for a relocatable 3.0m dome slab



Drawing BSLT3.0-2 Section - for relocatable 3.0m dome slab



SLAB FORMWORK for a RELOCATBLE 3.0M DOME
REF: Drawing BSLT3.0-2a

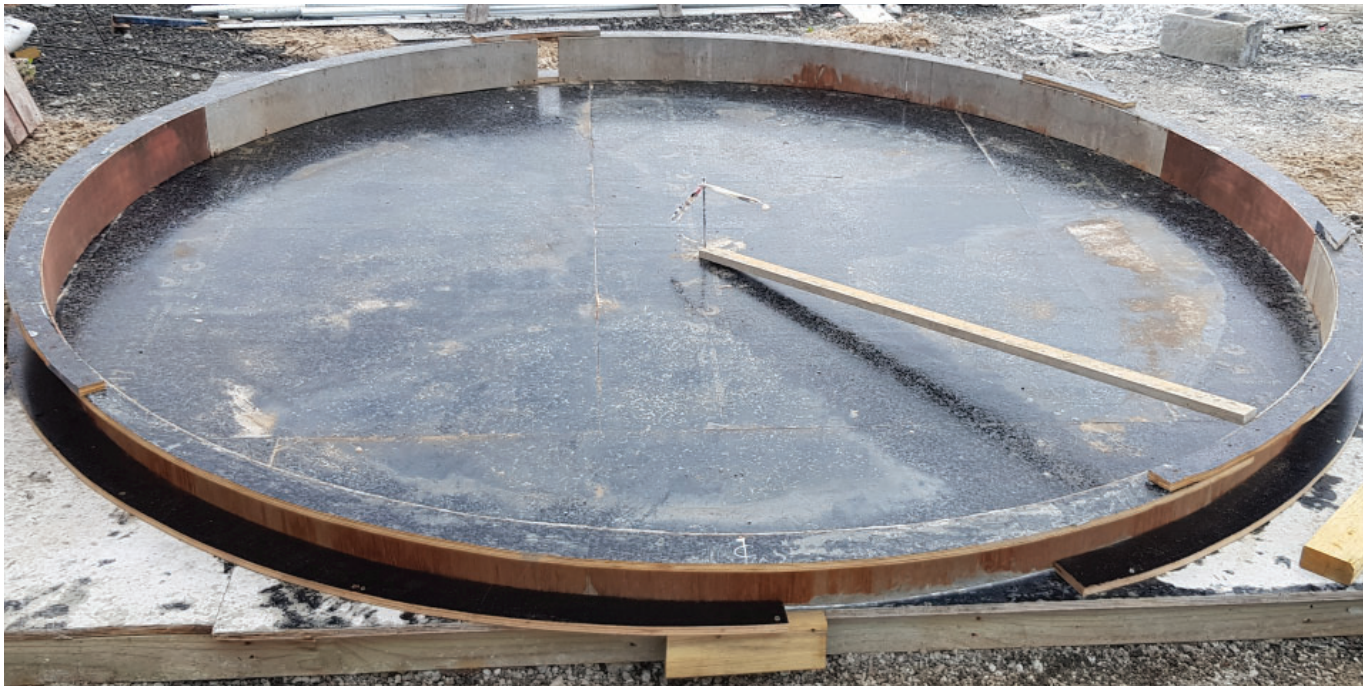
Fabricate a plywood fence at the finished height of the concrete around the circumference of the slab - 150mm thick.

Materials:

- **Rails -** plywood - 16mm (or 17mm) form-ply
- **Slab edge form** - 4mm plywood to bend around the perimeter of the slab edge **Pegs -** hardwood pegs - to hold the slab form in place at the correct height

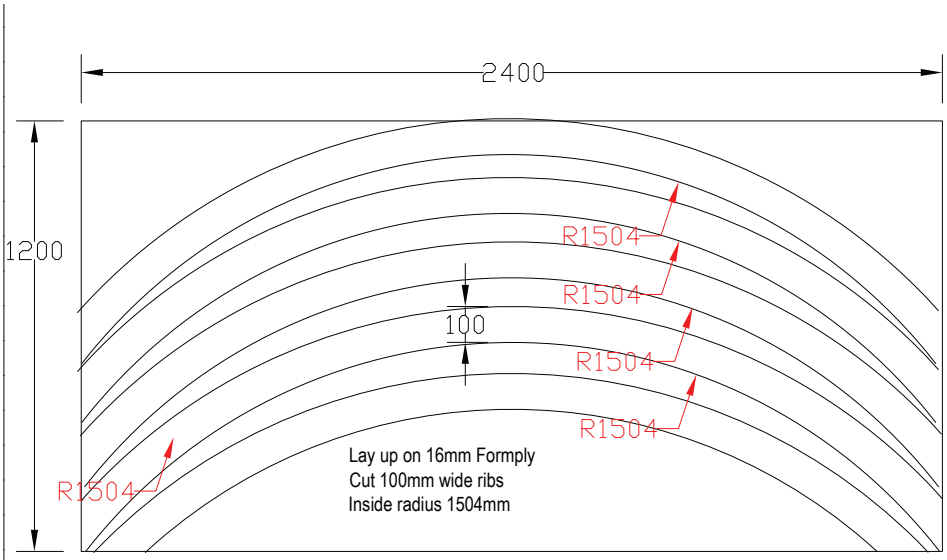
The Slab Formwork fixed down onto the platform.

NOTE: the pin at the centre of the slab. A timber stick from the pin measured 1.5m to gauge the exact distance to the outer circumference of the formwork



The profile of the relocatable 3.0m slab formwork - 150mm high for a 150mm thick slab
Join sections of this profile to form the 3.0m diameter slab formwork.

Drawing BSLT3.0-2a

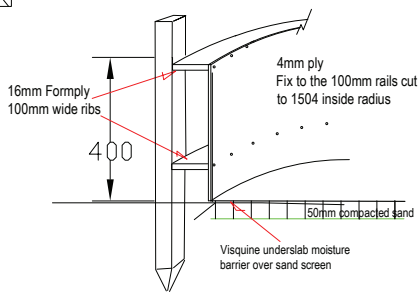


3.0m diameter Dome
Typical Slab Former Detail

The finished diameter of the slab is 3.0m
the radius is 1.5m

Use 4mm ply for the vertical edge
Use 16mm formply for the outer ribs
Cut 100mm wide ribs with inside radius of 1504mm .

Typical slab form detail for a slab on ground. NOTE: the depth of the ring beam footing could be between 400mm to 600mm



The designs contained within the set of drawings: BSLT3.0-1 to BSLT3.0-10 are to be read simultaneously with the "Basalt Dome Building Manual" and the "On Line Dome Building Workshop". They are for educational purposes only.
The shell is designed to wind speed of 51 mps for a particular site and foundation system designed for that site.
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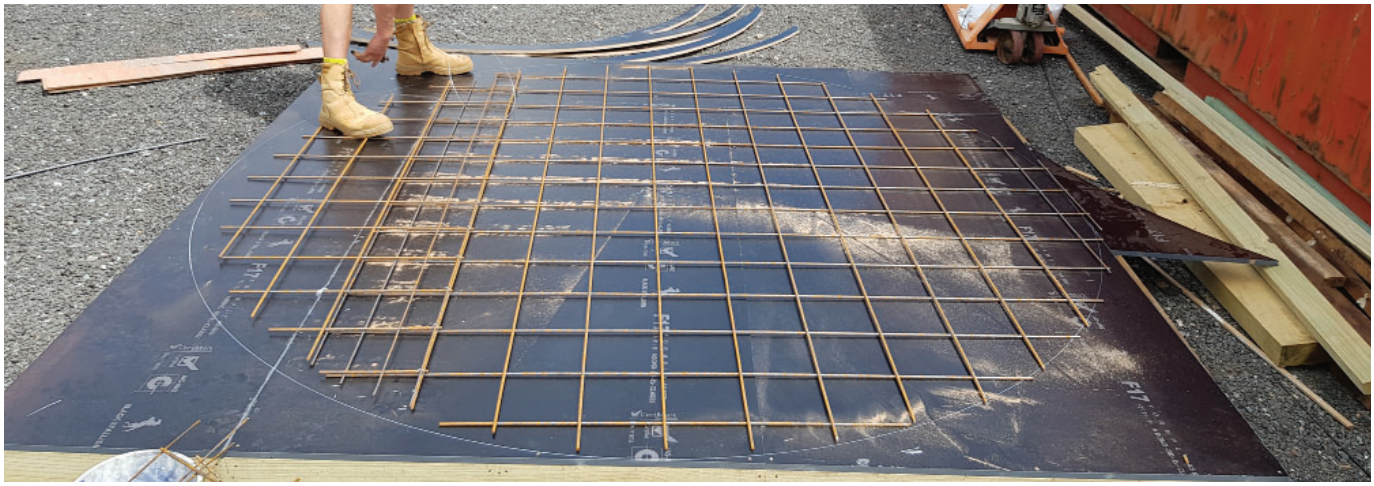
Fabricate the Slab Edge Formwork in Sections

- Cut curved rails or ribs from the 16mm ply at 100mm wide. (i.e. a 3.0m diameter slab will have an inner radius of 1.5m less the thickness of the edge ply - in this case 4mm
- Make up enough sections of ribs to go twice around the full circumference of the slab
- The ribs hold the vertical 4mm ply in place around the slab
- Cut the 4mm ply across the grain (1200mm wide). Cutting the ply this way makes it easier to bend the 1.5m radius).
- Cut the 4mm ply to the depth of the external ring beam - OR for a slab on ground to whatever height is required to hold the concrete from the ground level to the top of the slab
- Assemble sections of the slab form - Take two ribs - one for the top rail and one for the bottom rail and fix the 4mm ply to the edge of the rails.
- When enough sections of the slab edge form are made they can be joined together to form the complete circle of the outer edge of the slab.
- The former height for a relocatable dome is 150mm
- **The image below shows a slab form fixed to a ply platform - this is a relocatable structure.**

SLAB STEEL & LIFTING ANCHORS for a RELOCATBLE 3.0M DOME
REF: Drawing BSLT3.0-2
Plan and Section - Reinforcing for relocatable 3.0m dome slab

Slab Reinforcing

- Slab Mesh - this is the steel mesh (8mm bar x 200x 200 grid) - in Australia referred as **SL82)**
- Ring Beam Reinforcing - either 3 x 12mm steel bars OR 3 x 8mm basalt fibre rebars
- Cross Beam Reinforcing - 3 Bar trench mesh or 3 x 10mm basalt fibre rebars
- Angle connections - place at intersections of cross beam and ring beam reinforcing
- Addition 12mm steel bars around the position of the four lifting anchors
- Cut the slab mesh (SL82) before fixing the formwork - is easier
- Allow 40mm distance from the steel to the edge of the formwork



- Formwork is fixed down
- Black builders plastic is laid on the floor as a bond breaker between the concrete and the platform
- 3 bars form the outer ring beam reinforcing - the example below - 2 inner bars are 10mm basalt bar - the outer bar is steel for additional shear reinforcement for lifting
- 3Bar 8TM (Trench Mesh) is used for the cross-beam reinforcing - lifting anchors are placed on the edge of the slab over the Trench Mesh
- The example below shows lifting anchors being cast into the top of the slab - one option
- We recommend to cast lifting anchors into the edge of the slab

LIFTING ANCHORS for a RELOCATBLE 3.0M DOME - cont.
REF: Drawing BSLT3.0-2
Plan and Section - Reinforcing for relocatable 3.0m dome slab

Where to get your lifting anchors?
A great supplier in Australia is **Actech.com.au** with branches in Sydney, Melbourne and Brisbane.

All types of lifting anchors are available at ACTECH.
Each anchor must be rated to 5.0 tonnes - order the accompanying rubber void former

https://actech.com.au/?s=TKA+edge+lift+anchors&post_type=product

Lifting Anchors for the **Top of Slab** installation

Lifting Anchors for the **Side of slab** installation

Bar Chairs
To support the steel off the floor
For the relocatable slab, we support the steel 60mm off the floor

POURING AND FINISHING a RELOCATABLE SLAB

The concrete is delivered by a ready-mix truck.
Concret emix design for the slab is:
32Mpa
9mm aggregate size
It is acceptable to use a 20mm aggregate.
The reason we use a 9mm aggregate is that it easier to screed, float and finish.

Evenly spread the concrete to the top of the formwork that is fixed at a consistent level.
To ensure well compacted concrete - it should be vibrated.

Note the vibrator wand in the concrete that also helps spread the concrete

Once the concrete has been evenly spread using a shovel and the vibrator to the top of the formwork, it is ready to be screeded. Using a concrete screed or another straight piece of steel, aluminium or timber off the top of the formwork.
Use a back and forward motion to get a completely even level of the concrete.
Remove excess concrete.

The next stage is to float the surface.

It is common to use a “bull-float” for this operation.
Depending on your skill level you may also achieve a sealed smooth finish using a hand trowel. A magnesium hand trowel gives the best finish

The final stage of finish is to use a steel trowel to polish the surface.

This can only be done when the concrete is at a certain stage of setting.
The concrete must not be wet, but firm.

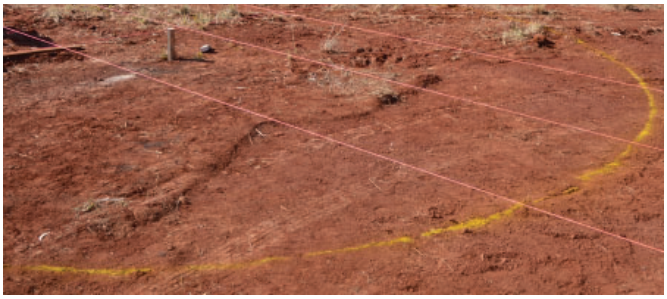
The final steel trowel finish enables a smooth finish to the concrete without bubbles or blemishes.

Set Out for Footing and Slab on Ground

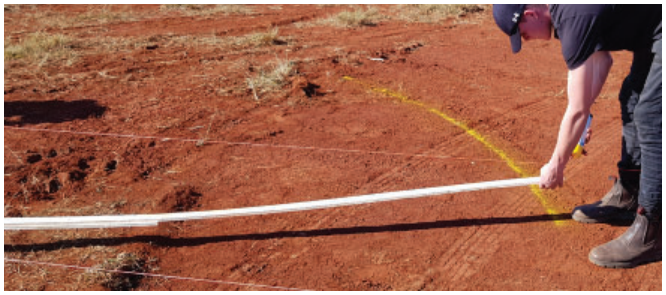
For a dome slab and footing we first need to define the perimeter of the slab.
Begin with a peg in the ground at the centre of the slab location.

1. Keep the peg relatively low to the ground.
2. Fix a nail or screw at the centre of the peg.
3. Using a tape measure from the centre point mark a circle on the ground the exact radius of the slab.
4. Determine the finished height of the slab above the ground.
5. Dig the perimeter footing to the designed depth and width specified in the engineers' slab design.
6. Keep the depth and width of the footing as exact as possible.
7. It is better to be a little deeper than not deep enough.
8. A little extra depth can easily be filled with sand.

An 8.0m dome - the circumference of the footing is traced out from a central peg - radius of 4.0m



The ring beam footing is excavated



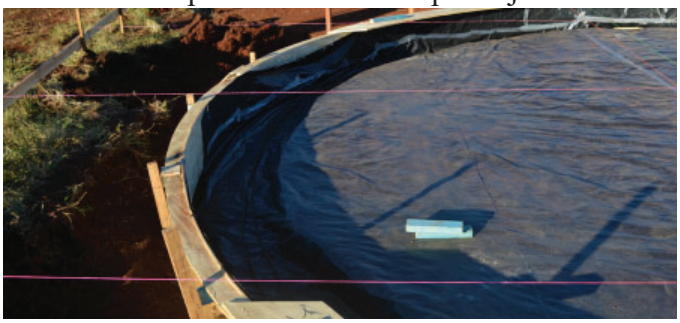
The formwork is fixed in place at the finished height of the slab - sewer and drain pipes in place

Height of the formwork is 400mm

Formwork fixed - sand layer covers the entire underslab area to cover sharp stones

FORMWORK for an ON GROUND FOOTING & SLAB - continued

The entire underslab is covered with builders plastic as a vapor barrier. Duct tape all joins.



The slab mesh steel and footing steel is in place and supported by plastic bar chairs

- Drive the pegs into the ground adjacent to the forms and fix the forms to the pegs at the exact height of the slab -Levels can be obtained using a laser level, dumpy level or even a water level.
- when all the edge form is fixed in place the area inside the form-work can be cleaned of debris and a layer of sand or other fine material laid down, levelled and smoothed out
- lay purpose made “under slab” plastic barrier over the sand up the side of the ply form
- join the laps using a joining tape
- place the footing steel or basalt bar in the footing trench around the perimeter (as per drawings)
- lay the steel mesh over the entire slab area
- prop all the steel up on bar chairs at the height specified in the engineer drawings

Ready for Concrete

Footing reinforcing in place - Electrical conduit installed - Bathroom drainage pipes in place and sealed to plastic with Termite mesh collar.

Footing
A footing (also referred to sometimes as a strip footing) is a beam of reinforced concrete bearing on the ground and supporting the structure above. Footings can be installed (poured) on their own or they can be poured incorporated into the slab . Then it becomes part of the raft slab.

Piers
In some circumstances the engineer may specify that piers (or piles) be incorporated in the footing.

A pier is when a hole is drilled into the earth in the same channel as the footing. The pier hole will have reinforcing bars placed in it that connect to the bars in the strip footing and the pier hole is then filled with concrete when the slab is poured.

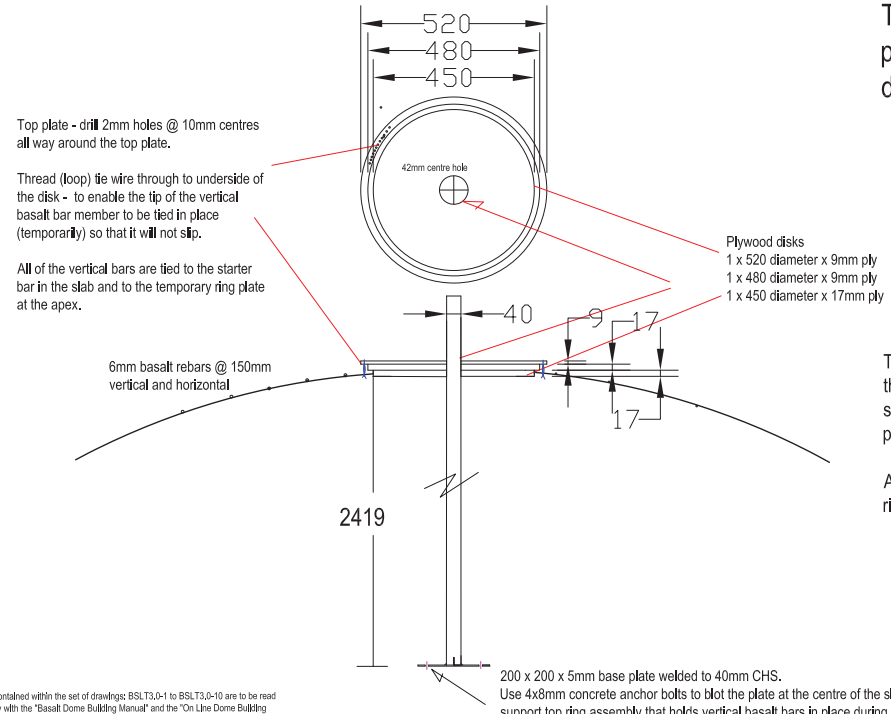
In residential footing a pier hole is typically about 300mm to 400mm wide and is created by an auger operated on a bob-cat.

When are piers designed into the footing
Engineers will design piers into the foundations for several possible reasons. The main reason is to reach a firmer ground bearing when the soil in the top layer is not well or sufficiently compacted to accept the load of the structure.

Starting with strip footing only
The footings and slab can be poured separately.
That is just the footing is poured first on which the walls are constructed and the slab is poured at a later date, often after the walls and roof are up. In some circumstances this may be preferable.

Typical Bob Cat with Auger
for pier footings

CENTRE POLE ASSEMBLY
REF: Drawings BSLT3.0-3 & BSLT3.0-6



The Carousel Apex Temporary Ring plate assembly detail - for a 400mm diameter apex skylight hole

The pole and carousel assembly acts to temporarily hold the vertical basalt bars in place until the shell is sufficiently rendered to within 50mm around the perimeter of the carousel.

At this point it can be removed and the pre-cast skylight ring is placed in position and rendered into the shell

The designs contained within the set of drawings: BSLT3.0-1 to BSLT3.0-10 are to be read simultaneously with the "Basalt Dome Building Manual" and the "On Line Dome Building Workshop". They are for educational purposes only.
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Domeshells Australia Pty Ltd
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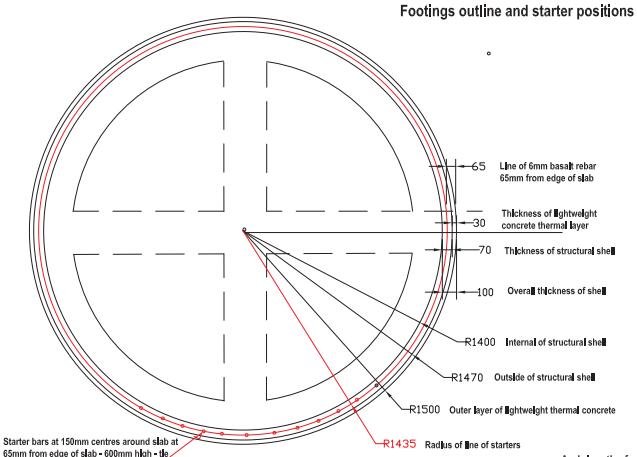
dome shells

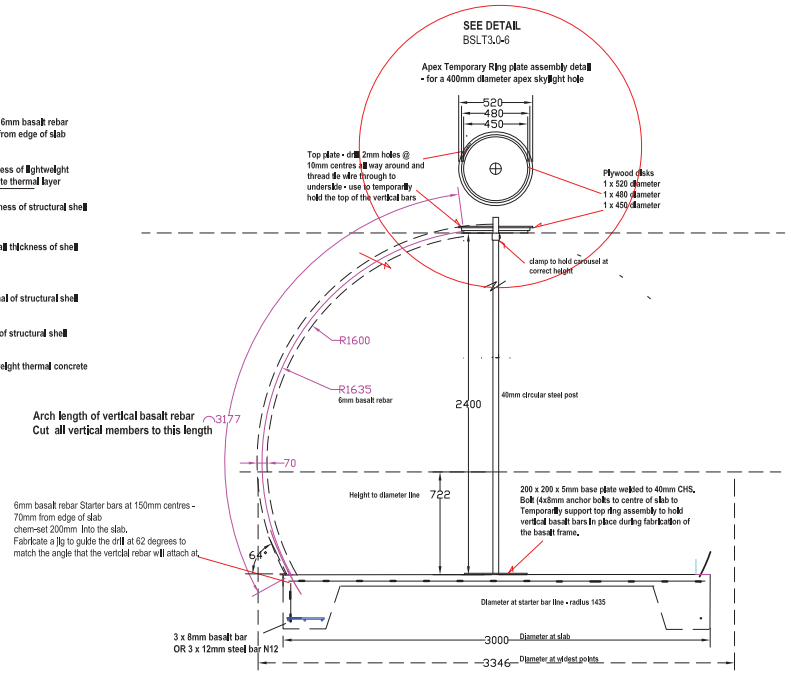
References			
Approve			
Checked			
Drawn		COB	
Date		07/12/2023	

3.0m Dome
Temporary Pole and Plywood Disk Ring Assembly
The Carousel
DETAIL

Sheet 1 of 1
A3 -Scale 1:10
DWG:
BSLT3.0-6
REV.

PLAN DETAIL
Footings outline and starter positions





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REV	DATE	BY	DESCRIPTION	GRID REF	CHECKED	APPROVED

DomeShells Australia Pty Ltd
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https://www.domeshells.com.au

dome shells

References			
Approve			
Checked			
Drawn	COB		07/12/2023
Scale:	Name	Signature	Date

3.0m Diameter -
Basalt Fibre Reinforced Dome Shell
Vertical Bar Placement
and assembly
DETAIL

Sheet 1 of 1
A3 -Scale 1:25
DRG. No.
BSLT3.0-3
REV.

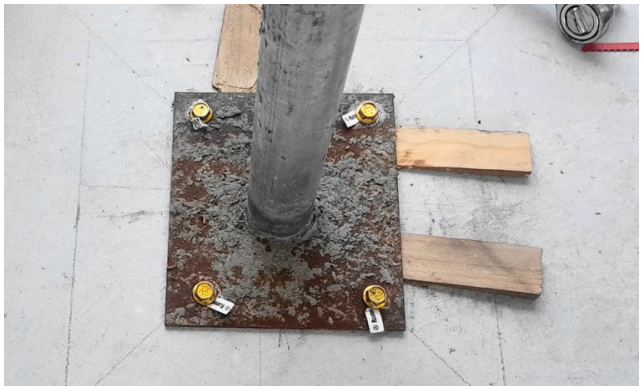
CENTRE POLE & CAROUSEL ASSEMBLY

We use a steel pole fixed to the centre of the slab to temporarily support a **plywood carousel** at the correct height to temporarily support the top end of the vertical bars.
The carrousel is used to tie the ends of the vertical bars and support them in place during the construction.
When the construction reaches a certain stage we remove the pole.

The pole in the example is a **40mm diameter steel pole** with a 150mm x 200mm x 5mm steel base plate that is bolted to the centre of the slab.
Mark the centre of the slab. Place the pole in position and drill through the four holes into the slab so that it can be bolted to the slab.
We generally use 8mm x 50mm concrete bolts for this purpose.
It is essential that the pole is mounted so that it is plumb.

The plywood disks assembly is clamped to the pole at the determined height - in this case the drawing indicates a height of 2.418m

The base plate of the centre pole in this example, is bolted into the slab using 8mm concrete bolts. Timber wedges are used to adjust the pole to be vertically plumb.



Adjust the wedges under the base plate until the pole is standing plumb in all directions. use a spirit level to check

Two different examples of supporting the carousel disk.

The Centre Support Pole with brackets welded at the determined height to support the ply disk ring assembly

Below
A short length of pipe with wider diameter to slide over the 40mm pipe. It has a lock-nut welded to the short pipe so it can be tightened to clamp itself on the 40mm pipe. This can be adjusted to hold the carrousel. One clamp above and one clamp below.

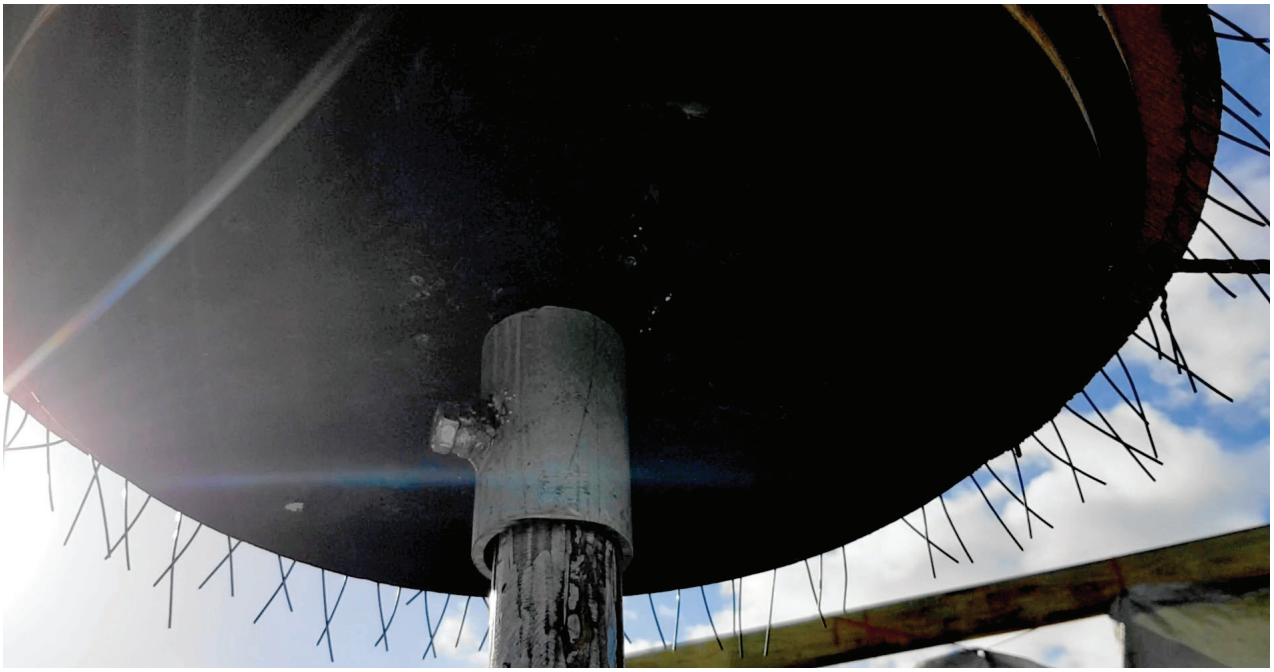
CENTRE POLE & CAROUSEL ASSEMBLY - continued

The centre pole in place on the slab with the carousel attached.

PREFABRICATED POLE ASSEMBLY

Carousel Ring Assembly
The plywood ring assembly is fixed at a pre-determined height on the pole in such a way that it is fixed rigid and wont move.
The carousel held in place on the pole - supported at the desired height by the sleeve with the locknut.
The carousel ring assembly is fabricated to create the desired opening width of the skylight and acts as the point where the vertical bars are connected to at the apex.
In this case we plan an opening of 400mm inside diameter.

Close-up view of the ring being supported on the pipe by the clamp holding in place at the desired height on the pole.



PLYWOOD FABRICATED CAROUSEL

To Create an Apex Opening - Method One

The following ring assembly design is specifically for the creation of an apex opening for a skylight.

The ring assembly (in this case) comprises 3 plywood disks. The two smaller disks are cut from 16mm ply, the top disk is cut from 9mm ply. NOTE the disks can be cut from almost any thickness plywood.

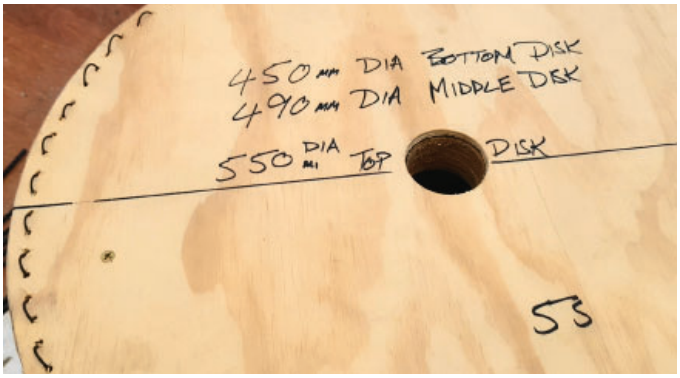
One disk top - 550mm diameter
One disk middle - 490mm diameter
One disk bottom - 450mm diameter

With a hole saw, drill a 42mm hole at the centre to be able to slip the disks over the pole.

Drill 2mm holes 10mm in from the edge of the outer disk every 10mm around the edge of the top disk.

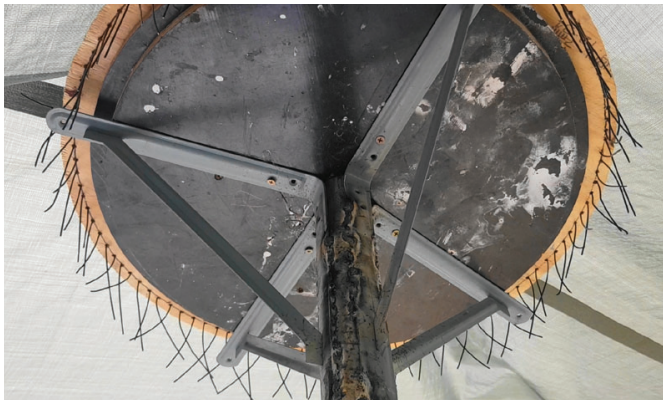
Loop a length steel **tie wire** through every pair of holes. This wire will be used to tie around the top of the vertical basalt bar to hold it in position during the basalt dome cage fabrication process.

Top ring plate - with diameters of the three ring-plates marked.



The three disks clamped and fixed together with the tie wire inserted throuigh the holes.

Close up of the carousel on the pole where we will tie the vertical bars in place for the fabrication of the shell.
\NOTE: The carousel is there temporarily - It will be removed at the right time.



PRE-FABRICATED CONCRETE APEX RING

To Create an Apex Opening - Method Two

This method utilises a pre-cast concrete ring that acts as:

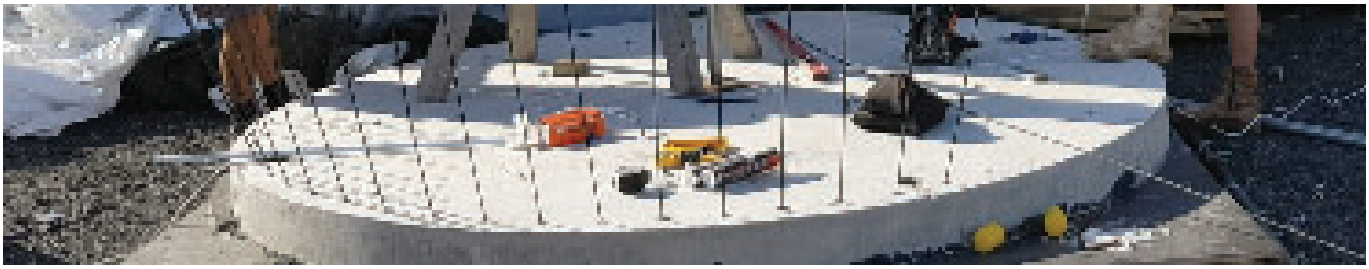
1. the carousel to tie the vertical starters to
2. as a pre-finished opening at the apex
3. as a hob that projects above the level of the dome - over which the skylight is placed

Below - is what it looks like when held in place at the correct height on the centre pole.
The vertical bars are tied in place in a similar way to how they would be when using the ply wood disk method.

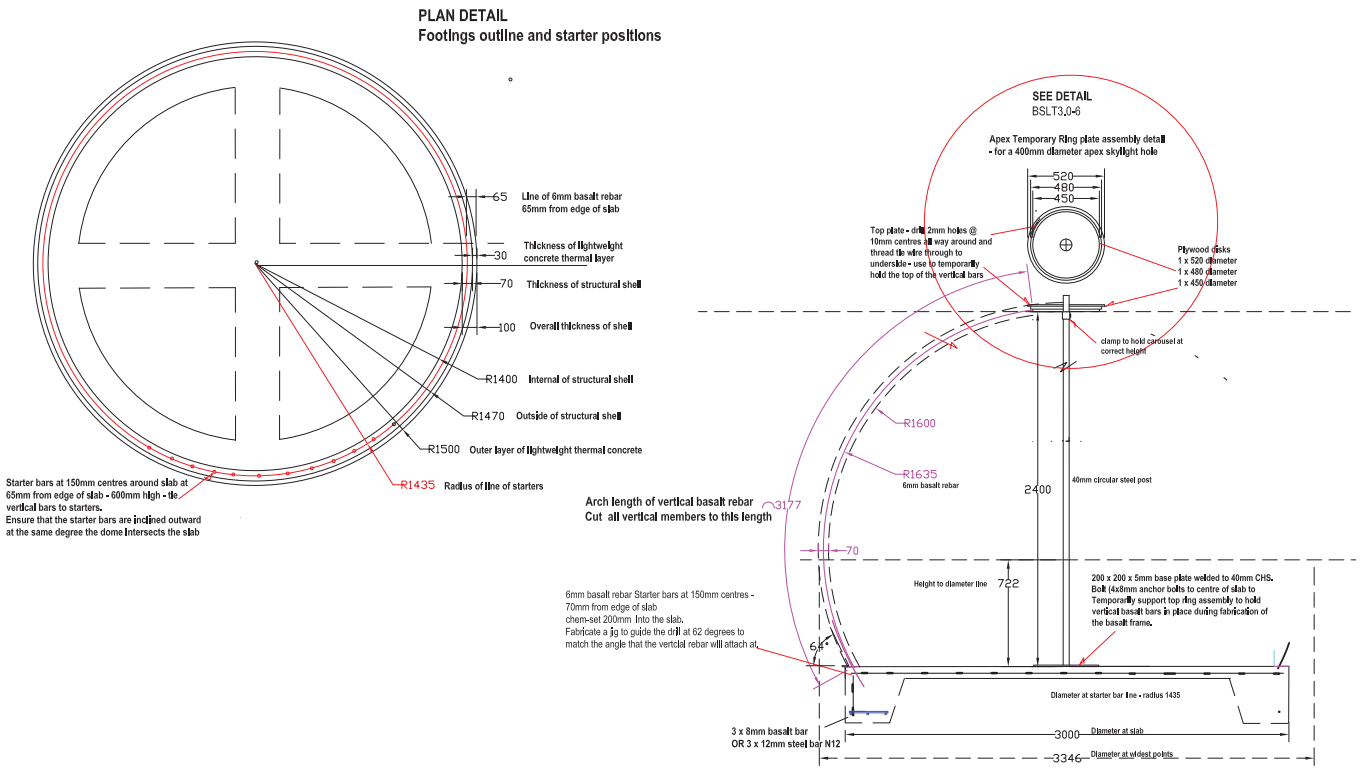
How to fabricate the concrete ring and other elements such as a door and window frame are covered up ahead

A Pre-fabricated Concrete Apex Ring and Hob

INSTALLING the STARTER BARS



REF: Drawing: BSLT3.0-3



Check plans, dimensions & structural design

Working with **basalt rebar** is a pleasure compared to steel for a number of reasons:

- It is only 20% the weight of steel - easy to use
- It is easy to cut - use angle grinder or bolt cutter
- It has perfect flexural qualities that allow it to be bent around a dome curve
- does not blacken the hands

NOTE:

- **Wear gloves when handling basalt rebar to avoid loose fibres prickling the skin**
- **Wear a dust mask when using and angle grinder to avoid breathing the dust.**

Depending on the engineers structural design of the dome the spacings of the bars will be between 100mm and 200mm.

In most cases the spacing will be 150mm centres
For the workshop dome they are spaced at 150mm centres which means we should have starter bars fixed into the perimeter of the slab every 150mm.

INSTALLING the STARTER BARS - continued

The starter bars are reinforcing bars that are either placed in the concrete while it is wet or are fixed into the cured slab by means of a chemical anchor.

Installing Starters in Wet Concrete
Typically, if the bars are being placed in the wet concrete they will be 700mm long bars with a 100mm **right angle** turn at the base.
In this case they can be tied to the footing steel to be held in exact place during the pouring of the concrete.
Starter bars shall extend 600mm out from the slab. This can be tricky to achieve because the starters need to be angled to meet the angle that the dome meets the slab. One option could be to install steel starters in the vertical position and then bend them out to the desired angle when the concrete is set.

Installing Starter Bars in the Cured Concrete With "Chem Set" - Our preferred method

In this case holes are drilled in the concrete in which to insert the starter bars together with a chem-set mixture from a tube.
Drill the starter bar holes to a nominal depth of 120mm.
Cut the starter bars (6mm basalt bars) to 700mm so that the bars extend out from the slab about 600mm
For a 6mm bar we use a 7mm masonry bit.
Exposed starter bars are a health and safety risk - place bar caps over the top of the starters immediately after installing

Extremely Important - Blow the concrete dust out of the drilled holes.

The most efficient way is to use an **air gun** to blow out ALL the dust from the drilled holes. It is **very important** to blow all the dust out to ensure that the chem-set material properly adheres to the concrete.

- Trace a radius line around the slab where the starters will be placed.
- Start anywhwere and make a mark at every 150mm which is where to drill a hole.
- The block of wood in the image has been cut on one edge at the angle that we want the starters to protrude from the slab to match the angle that the dome shell meets the slab.
- When drilling the holes use the angled block at a guide.
- Ensure that the holes are drilled perpendicular to the centre pole. NOTE: A straight edge placed on the slab from the hole to the centre pole to help line up the drill perpendicular to the pole
- After the hole has been drilled - using an air gun - thoroughly blow out ALL the dust from the hole
- Now the holes are ready for installing the starters

INSTALLING the STARTER BARS - continued

Below Image - Teamwork

- The holes have been drilled
- The holes have been blown out using the airgun
- The holes are being filled with chemset
- The starters are installed in the holes
- Install the starters by twisting the starter as it is inserteddown to the full extent of the hole
- Starter caps are placed over the starters as a health and safety measure.

Maintain the Correct geometry
Most important is that all the starter bars in the slab are at the same consistent angle to maintain a consistent geometry of the dome shape.

The doorway.
Install starter bars all the way around the slab including into at the doorway. They are needed. They will be removed later.

Basalt rebar comes in coils - usually coils of 100m or 500m can be ordered.

Basalt rebar can be cut using conventional bolt cutters or with an angle grinder steel blade.

Always wear a dust mast if cutting with and angle grinder.

Wear gloves when handling basalt rebar to avoid being prickled by little hairs that may protrude from the bar.

INSTALL THE VERTICAL BARS

FORMING THE DOME SHAPE WITH BASALT BARS
REF: Drawing BSLT3.0-3

The vertical bars are installed when:

- The centre pole is installed
- The carousel is in place - either the timber disk version OR the pre-fabricated concrete ring
- The starters have been installed in the slab at 150mm centres all the way around the slab

Cutting the vertical Bars

If the centre pole is fixed at the centre of the slab in a plumb position All the vertical bars can be cut to the same length. ***see the arc length is noted on the Drawing: BSLT3.0-3***

- Cut all the vertical bars to length on the ground according to the length shown on the drawing according to the size of dome you are building. The bars are tied tightly to the starters at 2 points with cable ties.
- The top of the bars are tied into the ring assembly at the apex.

Using a pair of "end cutter wire tiers" or pliers make sure that the bars are tied tight to the ring assembly to ensure that they cannot wiggle loose.

Tie the vertical bars to each starter in at least two places. One at the base where the vertical bar meets the slab and one near the top of the starter.

FABRICATING THE BASALT CAGE

- The initial stage of framing up the dome with bars is a bit like creating a bird cage.
- The vertical bars are installed first.
- They can all be pre-cut to exactly the correct length reaching from the slab level all the way up to the apex ring.
- The exact length will be noted on the Domeshells drawings **REF: Drawing BSLT3.0-3.**
- **The horizontal bar detail is in drawing: BSLT3.0-4**

A framed up dome cage before the window and door hoods are fabricated

A framed up dome cage WITH the window and door hoods fabricated

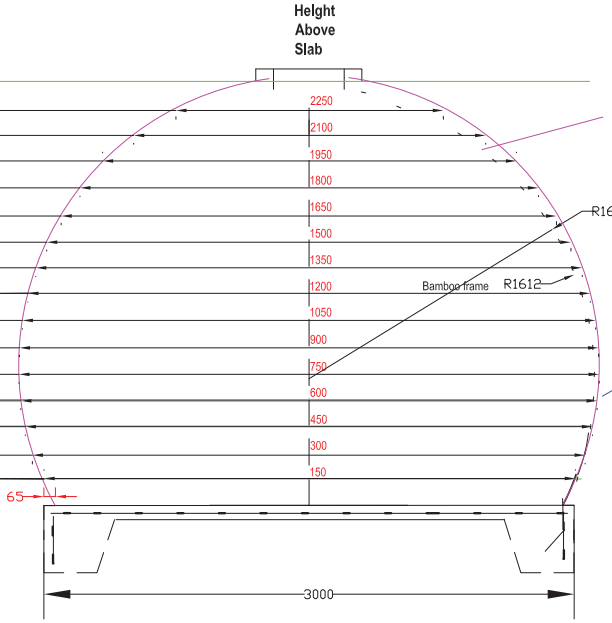
FIXING THE HORIZONTAL BARS
DRAWING: BSLT3.0-4

Fixing Horizontal Bars

- When all the vertical bars are fixed, the horizontal bars can be tied to the vertical bars.
- Horizontal bars are placed at every 150mm spacing starting with the first bar at about 25mm off the slab.
- The length indicated in the table on the drawing will be the exact circumference of bar at a particular height plus 800mm.
- The additional 800mm is to allow the bars to lap 400mm where they join.
- This allows you to pre cut the horizontal lengths indicated on the drawings.
- Shorter lengths of bar can be joined provided the joins are lapped by a minimum of 400mm.

3.0m - SECTION DETAIL
Horizontal Bar measurement - circumference at 150mm centres

Circumference plus 800mm for 400mm lap at join	Circumference	Height off slab	Diameter at 150mm centers
5555	4755	2250	1513
7061	6261	2100	1992
8157	7357	1950	2341
8953	8153	1800	2594
9606	8806	1650	2802
10122	9322	1500	2966
10518	9718	1350	3092
10801	10001	1200	3182
10995	10195	1050	3244
11099	10299	900	3277
11115	10315	750	3282
11043	10243	600	3259
10885	10085	450	3209
10628	9828	300	3127
10247	9447	150	3006



Shell structure comprising:
6mm Basalt Fibre Rebar at 150 vertical x 150 horizontal.
1 x layer of 5mm basalt fibre mesh (minimum 115gsm)

Render to minimum of 30mm thick cover over the framing externally and Internally - minimum overall thickness of 70mm

Apply 30mm lightweight thermal render (perlite aggregate or similar) over the structural shell.

Render mix design for Structural render
3 fine washed river sand to 1 general purpose portland cemen
1 cup Bondcrete

For sklm coat render add 2 grams 7mm basalt chopped fibre per 20kg cement
Apply by render spray machine

Starter bars in slab 600 high at 150mm centres.

Chemset 6mm diameter basalt rebar 150mm centres all way around the slab at the angle the curved dome meets the slab

DomeShells Australia Pty Ltd
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References
Approve
Checked
Drawn CB
Scale: 07/12/2023

3.0m Basalt Dome
Horizontal Bar Location & Lengths
Sections DETAIL

Sheet 1 - of -
A3 -Scale 1:20
Dwg: BSLT3.0-4
REV.

Tieing the bars together

Horizontal bar being tied to a vertical bar. The vertical bar is a starter bar with the full basalt bar attached and the horizontal bar is doubled up at the lap joint

Fixing the Horizontal Bars - Checklist

1. **Fix the first horizontal bar at the widest point of the dome** - this point is at 900mm above the slab.
2. On the table on the plans the overall length of this horizontal bar is 11.115m including the 400mm lap.
3. The reason for starting at this level is to establish the correct diameter at this point and to hold all the vertical bars in the right place. It allows for some adjustments and to get the spacing of the vertical bars correct.
4. Begin by tieing the first bar loosly enough to be able to adjust the position of the vertical bar
5. Next, start the horizontal bars from the slab level.
6. Work upwards fixing the horizontal bars up to the height that can easily be done working from outside of the slab.
7. At some point it becomes too difficult to tie the horizontal bars from outside of the slab and it will require to have access from inside the cage - working off the slab.
8. Now the cage is really starting to become more rigid.
9. It is now OK to cut out a hole in the cage to allow access into the inside.
10. It is important to maintain the shape of the cage and the extent of bars to be cut away should be the minimum required to prevent the bars springing away and effecting the overall shape of the cage.
11. At the place where the doorway will be - cut out approximately a hole about 3-4 bars wide by 3-4 bars high to allow access just large enough to get through by crouching.
12. Cut away the minimum that allows access.
13. Fixing the higher horizontal bars from inside the cage is much easier.
14. Fix all of the horizontal bars all the way up to the carousel.

These two images illustrate the extent of the cut-away bars to allow access into the cage

TYING THE REBARS

The essence is to tie the bars in a way that holds them tight. It could be string, wire or in our case we use **cable ties** just because they are fast and convenient.

It requires at least two people to fix a long length of basalt bar around the circumference.

Tie the first horizontal at the widest point keeping the ties a bit loose until it becomes certain that the spacing of the verticals is correct.

When the vertical and horizontal bars are in place it is necessary to ensure they are tightly held together so they do not slip - pull the cable ties tight!
Follow this procedure until all the rings/hoops are tied firmly in place.

Access into the slab area
It is strongly suggested that you install all the vertical bars except for 2 or 3 at the centre of the doorway to allow a person(s) to access the inside of the cage.

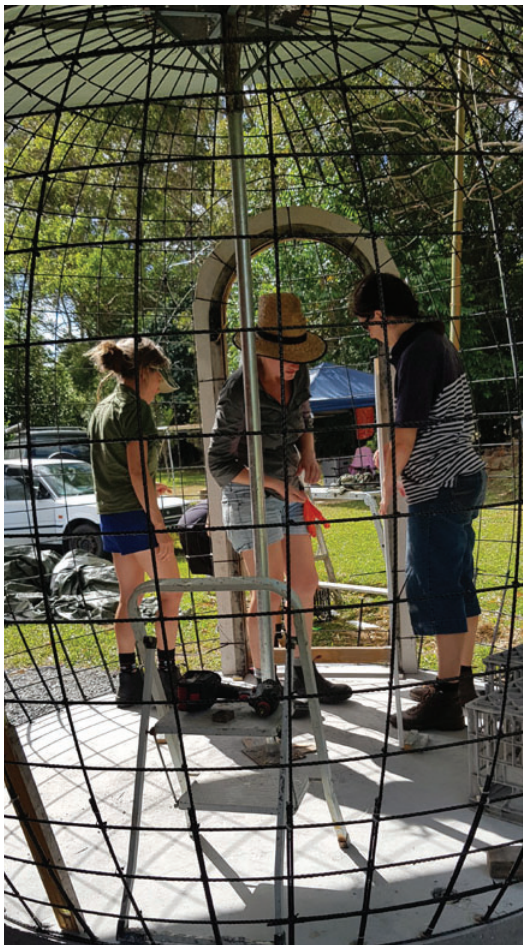
Essential quality control issues

In the early stages of fabricating the cage it is important to NOT cut away too many bars for the openings until the entire cage is complete with both the vertical and horizontal bars all tied together, the mesh tied on, the door and window frames in place and enough framing around the door and window openings to ensure that adjacent vertical and horizontal bars are integrated, tied together so that the cage cannot spring apart otherwise you might find yourself starting all over again.

Its all part of keeping the integrity of the shape together and in many instances it is best to actually have that first layer of render over the mesh as it will hold the shape and allow you to cut away bars through openings without worry of the bars unravelling and losing the shape.

In the example below, the bar spacing is 150mm but it may be specified as 100mm in some drawings. The spacing will depend on:

1. the size of basalt bar being used
2. the structural rating of the dome (as designed by Domeshells and certified by a Domeshells structural engineer)



When installing the horizontal bars, also keep them continuous around the cage. Maintain the position of all the vertical and horizontal bars even though they travel through door and window openings. Cut away the bars in door and window openings only when there is sufficient render over the frame to hold the shape in place.

INTRODUCTION TO PRE-FABRICATED ELEMENTS

From Here
We will divert to the Pre-fabrication of certain elements that we need next to incorporate into the dome cage

If you decide to use a pre-fabricated apex ring as the centre pole carousel then you will need to commence pre-fabricating prior to starting the basalt rebar dome cage.

The Next Stage
When the entire dome cage is complete with all the verticals and horizontals connected it is ready for the installation of the door frame, window frame and the mesh.

Basic Understanding
Now hopefully you have a basic understanding of how the dome shape is fabricated with the bars starting with the verticals tied to a centre pole carousel down to the starter in the slab.

The following pages cover the detail of how we make the moulds and pre-fabricate elements like the door and window frame and skylight rings.

At the end of this section we will return to the completed cage and the installation of the pre-fabricated elements.

PRE-FABRICATED ELEMENTS

We have found that it is beneficial to pre-fabricate certain elements of the dome build.

The elements we prefabricate achieve the following:

- It speeds up the rendering and finishing process
- It achieves a much better quality finish

The elements that we pre-fabricate in this case are:

- **The door frame** - we can cast the jamb rebate into the frame to the exact size of the door that means when we come to hang the door the opening is a perfect fit for the door. The door frame can be cast to any size or shape of door that you choose
- **The window frame** - at our workshops we usually look for an old, recycled window - preferably one that has some character like stained glass or if we can find one, a window with an arched head like an old church window. The prefabricated frame is made with a rebate to the exact dimensions that allow the window we have to be installed.
- **The apex ring -** pre-casting the apex ring means that we have the exact dimensions we require for the inside diameter of the opening. It also has the hob built-in that will extend above the height of the surrounding concrete shell that prevent penetration of rain when the skylight ring is placed over the hob.
- **The skylight ring -** the skylight ring is cast to the exact dimensions required to fit over the top of the apex hob and also with a rebate on the top side ready for installing glazing. We have glazed this opening using a 10mm tinted laminated glass and a 10mm thick tinted polycarbonate. Any glazing installed in the skylight must be safe enough to bare the weight of at least 150kg and must not be a type of glazing that could shatter and drop shards of glass into the dome below

Apex ring

Skylight ring

Door frame

Window frame

PRE-FABRICATED ELEMENTS - continued

Making the Moulds for the Prefabricated Elements

The prefabricated elements need to be made accurately - especially the door and window frames that are made exactly to the size required to fit the door and window perfectly.

Materials we use to fabricate the moulds.

All the moulds can be made in plywood.

We use:
16mm -17mm form ply - form ply is coated with a kind of finish that is designed to make it easier for the concrete to release.

9mm - 10mm ply - we use general construction ply for some parts of the moulds

3mm - 7mm ply - we use general construction ply for some parts of the mould particularly those parts that we need to bend.

Mix Design for all the Prefabricated Elements

Use a higher strength mix:

- 1 cement
- 2 sand
- .4 water (point 4)
- 50% of the liquid is either bondcrete or SBR polymer
- Mix the water and polymer together and stir thoroughly before use
- 200grms of basalt chopped fibre per 20kg cement

Mixing Order

- Thoroughly mix the sand, cement and water/polymer to its full consistency.
- Add the fibre by slowly sprinkling in the mix.
- Allow the fibre to mix for 3-5 minutes before using.

Reinforcing for Prefabricated Elements

Chopped Fibre - we have used different fibre lengths from 7mm to 30mm - The fibre definitely mitigates micro cracking and we have found that the 30mm fibre works better than the shorter fibre.

DO NOT OVER MIX THE FIBRE - over-mixing the chopped fibre will cause is to furball (clump)

Basalt Fibre Rebar - In addition to using chopped fibre all the prefabricated elements are further reinforced with 4mm basalt rebar.

Fragility of the Door Frame
The basalt reinforcing - rebar and fibre provide good reinforcing for the purpose.

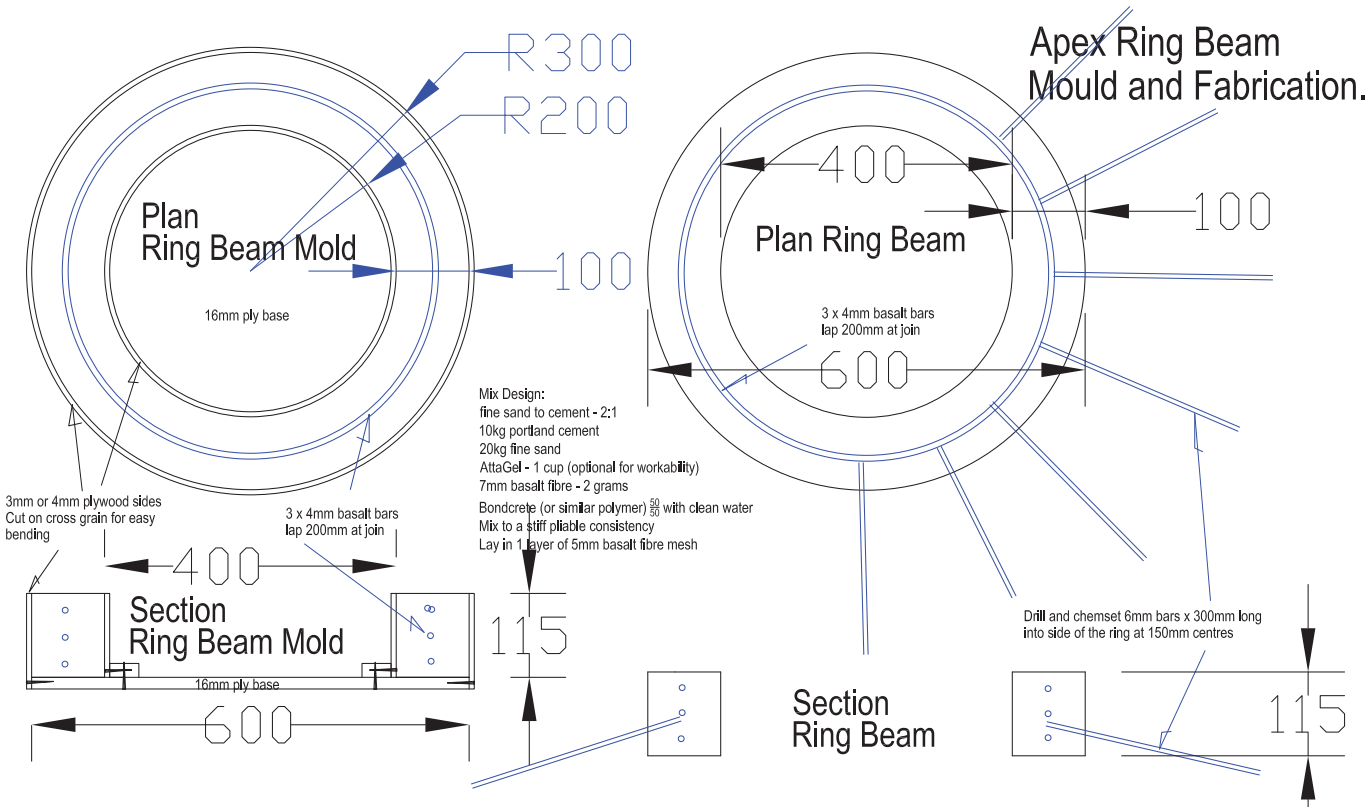
However, the door frame consists of a frame of only three sides and the frame is relatively small dimensions.
Great care needs to be taken to not twist or stress the frame once it is made to avoid cracking the frame element.

We commonly retain part of the mould attached to the frame to provide support to the frame during handling and installation.

PRE-FABRICATE the CONCRETE APEX RING

To Create an Apex Opening - Method Two

REF: Drawing: BSLT3.0-8



Options

Plywood Carousel - image right

The plywood carousel is a temporary element that will be removed at a certain stage of the dome fabrication. When it is removed, we can either fabricate a hob by hand OR we can place a concrete ring over the opening and integrate the concrete ring into the dome at a later stage.

We take a look at installing the prefabricated concrete ring to the opening created by the plywood carousel in the proceeding pages.

The Prefabricated Concrete Ring can be supported in place by the centre pole and fabricated into the dome from the start.
is a permanent element that will remain in place. It forms an important element of the dome.

It is an element that the vertical bars are tied to, and it will stay in place and will become integrated into the dome shell. It forms the opening at the apex and will project above the height of the surrounding dome to form a hob that the skylight will be placed over.

Now, lets go and see how we make the moulds and place the render mix.

PRE-FABRICATE the CONCRETE APEX RING - continued

To Create an Apex Opening - Method Two

REF: Drawing: BSLT3.0-8

Fabricating the Apex Hob Ring Mould
Refer to the drawing: BSLT3.0-8

The inner radius is 200mm to form a 400mm diameter concrete ring. The outer form radius will be according to the outer diameter of the ring - usually 80mm to 100mm for a 3.0m dome. We recommend 100mm.

Start by cutting the base plate from at least 16mm form ply - in this case 600mm diameter.

From the thinnest plywood you can get (3mm bends the easiest) cut two lengths across the grain at 115 to 120mm wide - these will form the sides of the mould. If the sheet of ply is 2400mm x 1200mm (8ft x 4ft) you will cut across the 1200mm (4ft) width.

On the base plate trace a ring with a 200mm radius. This is the line that the inner ply will be fixed at to provide the form for the inside of the ring.

This is what we are aiming to fabricate.
It looks a bit rough but will shape up fine when we install it in place.

There may be other kinds of thin bendable material that can be used for the inside form like some kind of plastic sheet that bends easily. If you have access to a material like this go ahead and use it.

The inner form needs to be fixed first.
Begin by fixing small 16mm ply blocks on to the base plate 3mm away from the line you have traced (if using the 3mm ply.

Set up on a bench and screw fix the inside form ply to the blocks.
Where the form joins place a short block of ply on the inside to screw the two end to. This will hold the two ends of the ply together. Ensure that the inner form ply is sitting vertical.

One the inner form is firmly fixed
Taking the pieces of the outer formwork proceed to screw fix the outer form to the base of the base plate ensuring that the bottom of the 3mm form is flush with the base plate to ensure the form is fixed vertical.

At the point the vertical forms meet there may be a slight gap.
ush the ends together and tape the two parts to hold them as flush and vertical as possible.

Another way to hold the shape would be to take some wire or cored and wrap around the top edge of the form and tie tightly to bring the form together at the joins.
The mould is now ready for placing the reinforcing bar.

The poured apex ring with temporary spacer sitting on top of the ring to hold the side evenly apart. The ring is reinforced with 6mm basalt rope laying to the left.

PRE-FABRICATE the CONCRETE APEX RING - continued

To Create an Apex Opening - Method Two

REF: Drawing: BSLT3.0-8

Placing the 4mm Basalt Rebar into the mould.

IMPORTANT: ***To make it much easier to remove the formwork when the concrete material is cured it is strongly advised to apply some kind of mould release.***
Any kind of oil will do the job. With a brush or rag apply the oil to the sides and base of the mould. Wipe away any excess oil.
Even cooking oil will suffice.

NOTE: In the drawing there are three rings of 4mm basalt bar.
Cut sufficient 4mm bar to form a ring with at least 300mm overlap.

The more overlap that you have, the easier it will be to form a perfect ring.
Tie the overlaps tightly together so they cannot slip.

Make the ring with a 500mm diameter so that when the ring is placed into the form it will sit about centre of the form.

The rings should be placed equal distant apart from each other.
One ring near the top, one ring about halfway down and one ring near the base.

Withe the three rings fabricated the ring form is ready for placing the render mix.

The easiest way to proceed is to:

1. place a layer of render into the mould
2. lay the first basalt ring into the mix
3. place another layer of render into the mould
4. place the second basalt ring into the mix
5. place another layer of render into the mould
6. place the third ring into place
7. place the final layer of render

Finish off the top of the mix with a trowel and cover with some plastic sheet to prevent moisture loss.
leave to cure for 7 days before de-moulding the part.
There is one more stage of the process before it is installed that we cover up ahead.

The mould is filled.
NOTE: in this image we have placed blocks in the top of the mould to hold a consistant spacing.

The concrete is cured and the spacer blocks are removed.

The part is demoulded.
In the image below, the hob ring has been fabricated taller than is required and was cut down to a lower profile before proceeding the next stage.

The Door - Cut from an external solid core flush door

- In our hands-on workshops we select an 820mm wide x 2140mm external solid core door.
- The reason we use a solid core door is so that we can cut an arch over the top of the door. We cut a full semi-circle radius of 410mm.
- Trace the arch and cut with a jigsaw.
- Sand the cut edge smooth.
- Paint an undercoat sealer to the cut edge to avoid any moisture absorption.
- In the 3.0m dome we also cut down the height of the door to 1900mm.
- First cut the radius on the door head and then cut the base of the door to the correct height.
- The reason we cut down the height of the door is because a taller door would mean that the arched hood over the door would need to be higher to allow the door to fully open.
-

(NOTE: using the methods and system in this manual you can make any opening size and shape that you choose

The Window

In our hands-on workshops we use a re-cycled window in a timber frame that we source from a re-cycled yard. We like to find an old window that has some character. Usually something with a stained-glass feature.
In this case we have chosen a matching pair of case-ment windows that have the original hinges and hard-ware still attached.

We are going to make a pre-cast frame for both the window and the door.

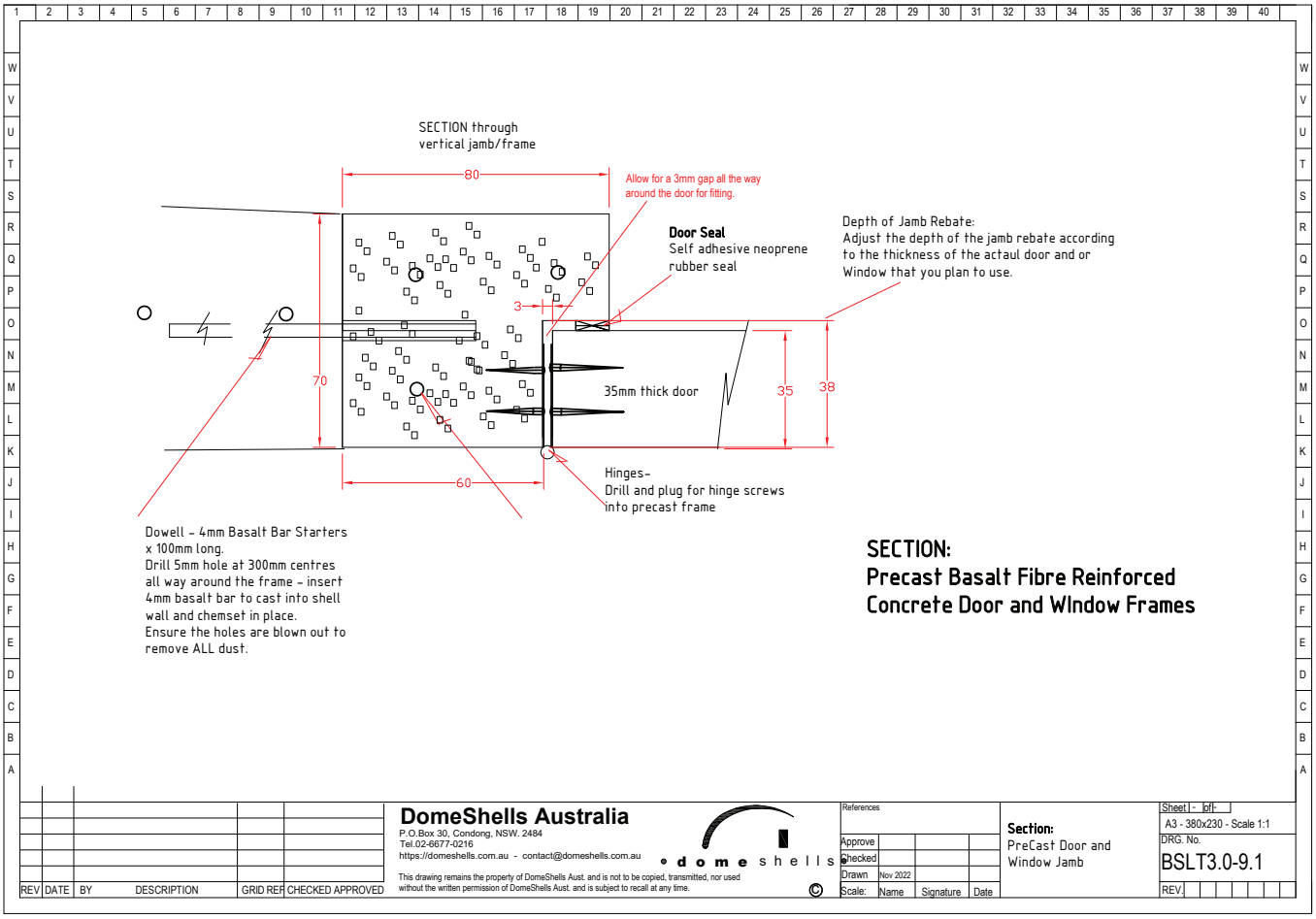
We know the exact size of both the window and door.

If we were making a timber frame, we would have to allow an opening size of the exact measurements plus fitting space to give the door and window space to open and close.

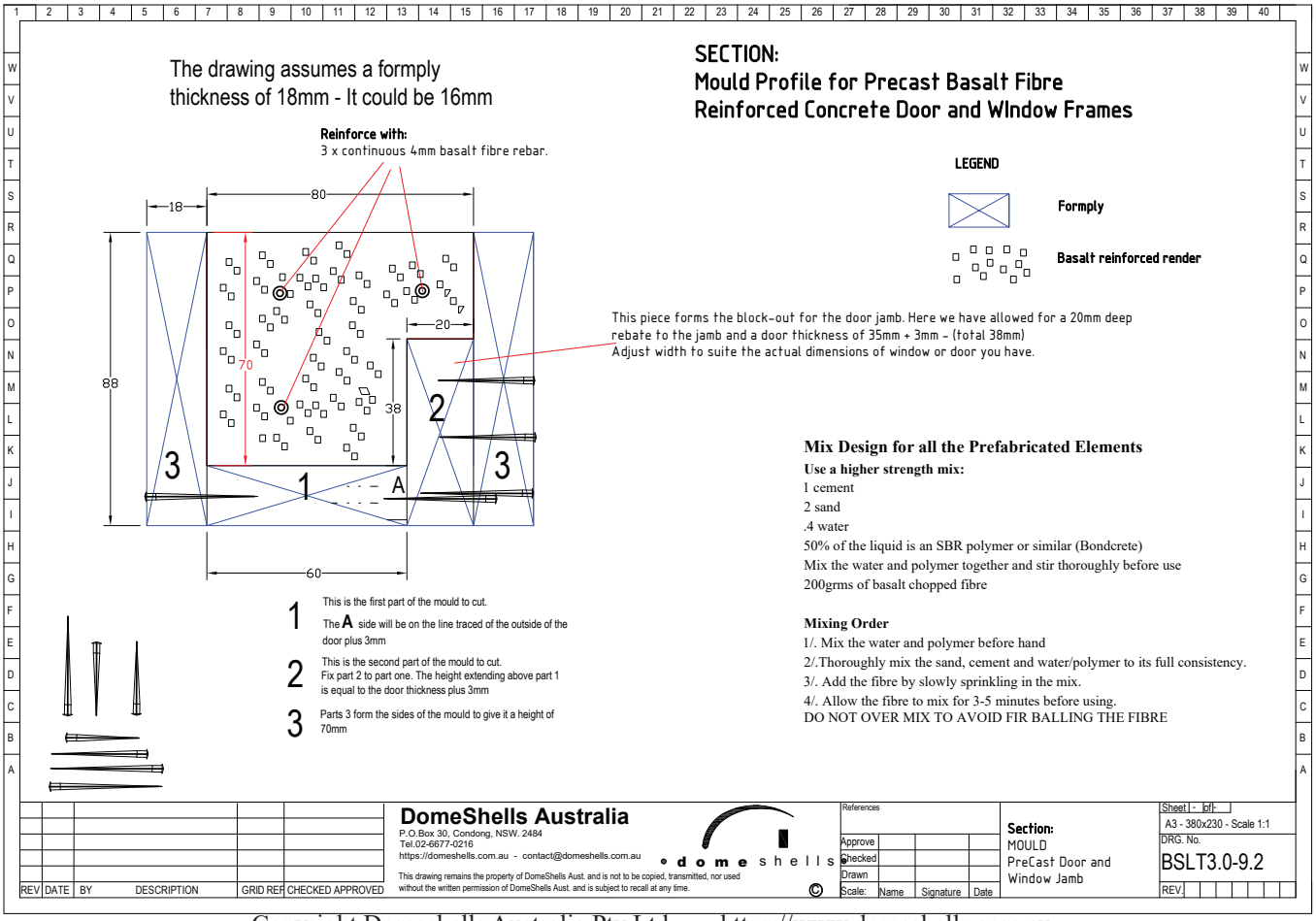
Fitting Space
WE allow 3mm on each side of the door and window for fitting.
That is 3mm all the way around the door, or window.
In the case of the door we will allow 5mm to clear the concrete slab.

THE DOOR AND WINDOW FRAME MOULD DRAWINGS
Ref: Drawings BSLT3.0-9.1 & BSLT3.0-9.2

The Drawing Below is a Section Through the Pre-Cast Door Jamb Frame and Door



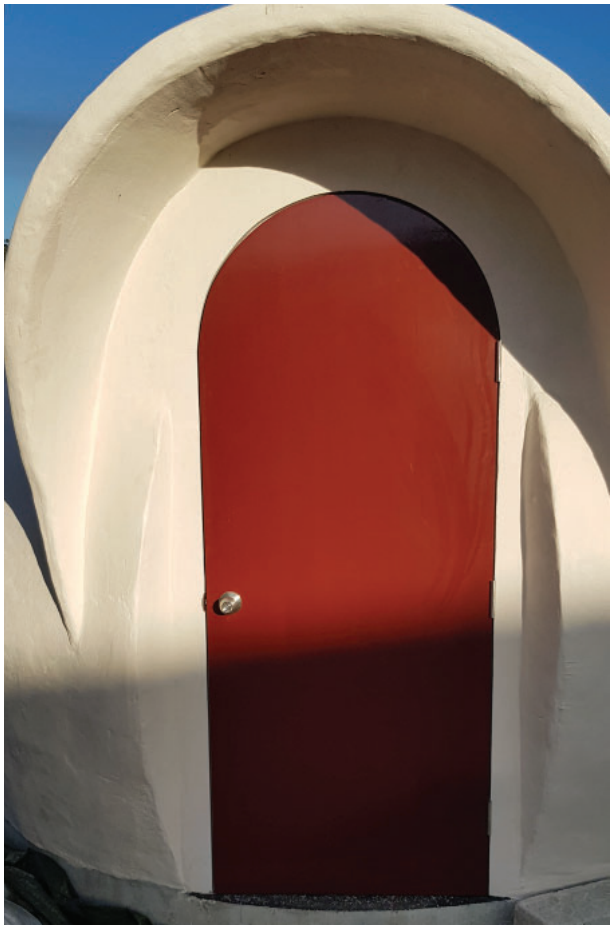
The Drawing Below is a Section Through the Mould of the Pre-Cast Door or Window Jamb



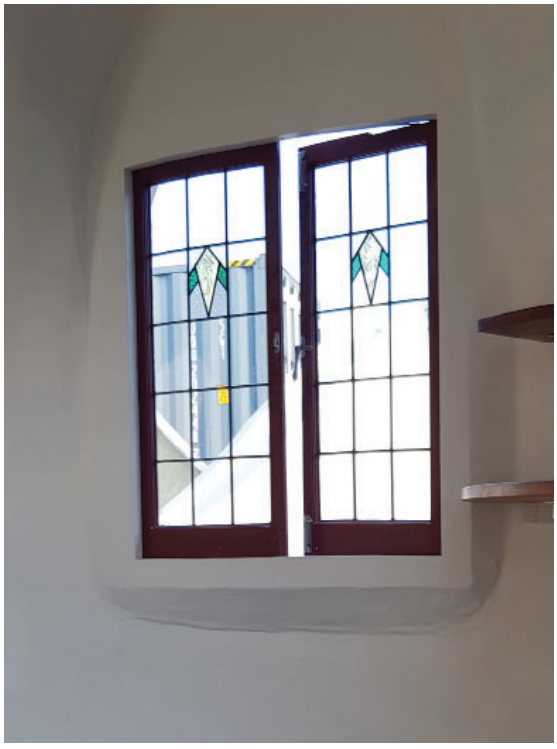
INSTALLED PREFABRICATED DOOR AND WINDOW FRAME
Ref: Drawings BSLT3.0-9.1 & BSLT3.0-9.2

The images below are the finished result of using the exact pre-cast frames that we fabricate in the moulds shown in the following pages.

The external solid core door (cut down) installed in the pre-cast frame. The pre-cast frame is fully integrated into the shell and appears seamless.



The pre-cast window frame is more visible in the images below. NOTE: the sill formed on the external view and the splayed render up to the frame from the shell to the frame on the internal image



PREFABRICATED DOOR AND WINDOW FRAME MOULDS
Ref: Drawings BSLT3.0-9.1 & BSLT3.0-9.2

Fabricate the moulds on an absolutely level table.

The door and window profile will be similar.

NOTE: The pre-cast door frame is a relatively delicate item for a concrete casting

On a flat level bench, the mould is mounted on top of another sturdy frame constructed from dressed 70mm x 45mm pine framing (dressed 3inch x 2 inch). This frame ensures that the mould cannot even slightly move which is extremely important for such a thin membered concrete element.

It ensures that we can transport and manouvre the pre-cast frame with the knowledge that it is well supported and mitigates twisting or raking the frame that might crack the frame.

PREFABRICATED DOOR FRAME MOULD
Ref: Drawings BSLT3.0-9.1 & BSLT3.0-9.2

We fabricate the mould so that it produces a pre-fabricatd element that is highly accurate to ensure the door or window fits properly without binding.
Cut down the door to the exact size it needs to be before making the mould so that the exact dimensions of the door can be used for making the mould.

To get the exact profile for the door. After, the door shape is cut and sanded.
BSLT3.0-9.2

Cut the profile of the base of the mould first as this provides the exact inside and outside dimensions of the mould.

1. Lay the door onto a sheet of formply and trace the outside of the door on the sheet of ply.
2. When you trace the door - first create a spacer of 3mm and use it to keep your pencil 3mm away from the door (exactly).
3. Cut exactly to the line you have drawn.
4. Next - draw another line 60mm outside the line traced around the door.
5. Cut exactly along this line.
6. When all the lines are cut it produces a U shaped form-ply element.
7. This is the base of the mould

NOTE: The liberal use of “builders bog” (2 part filler) that is used at the joins of the straight part to where the curved section starts to get a nice smooth transion. Any filling of this material must be sanded smooth. It is critically important that the mould presents the exact dimensions of the door or window plus the exact additional allowance for fitting - 3mm each side of the item.required. A mould will re-produce every detail when the concrete is installed the mould is removed.

PREFABRICATED WINDOW FRAME MOULDS

Use the same procedure to form the window frame to suite the size of sash/window frame you have chosen.

Below Image - The door and the window mould in fabrication

The window frame in this case is a complete rectangle and as such is significantly more sturdy that the door frame that is comprised of only two sides and a head and therefore can more easily twist.

CASTING THE DOOR AND WINDOW FRAMES ON A BENCH

Mix Design for all the Prefabricated Elements

Use a higher strength mix:
- 1 cement
- 2 sand
- .4 water
- 50% of the liquiid is an SBR polymer - (Bondcrete is an acceptable alternative)
- Mix the water and polymer together and stir thourouly before use
- 200grms of basalt chopped fibre

Mixing Order
- Thoroughly mix the sand, cement and water/polymer to its full consistency.
- Add the fibre by slowly sprinkling in the mix.
- Allow the fibre to mix for 3-5 minutes before using.
- Do NOT over mix after introducing the chopped fibre to avoid the fibre “fur-balling”

Reinforcing of The Window and Door Frame

- The channel created by the sides of the door and window moulds is filled with high strength fibre reinforced render and three 4mm basalt rebars that run continuously in the chanel.
- Cut the rebar to length before starting the render.
- Lay the bars into the render as the render is poured into the channel.
- It may be necessary to use spacers to keep the bars in the centre of the channel.
- Lay the first 20mm thickness of render and then lay in the first bar.
- Lay in another 20mm of render and then lay in another bar

Reinforcing of The Window Frame at the Corners

It is important to have a einforcemnt connection at the corners of the mould to connect each side of the frame where the connect at the corner.

- Basalt rebar cannot be bent like steel to form a right angle - (right angle elements in basalt bar must be manufactured)
- The 4mm basalt rebar is laid into the chanels.
- Use basalt mesh at the corners to connect.
- Cut several lengths of mesh - 25mm mesh is preferable due to it’s superior strength.
- If using 25mm msh - then 2 strips 50mm wide x 200mm long can be place at each corner so that they are embeded into the mix 100mm each side of the frame.
- If using 5mm or 10mm mesh then repeat the same process using at least 4 lengths per corner.

The intent is to place lengths of mesh that are placed into the render mix and bend around the 90 degree corner of the mould to provide a reinforcemnet connection at this point.At the corners

Avoid air cavities and bubbles in the finished frame.

- When placing the render into the mould, ensure that the material is well packed (using fingers) into the corners of the mould.
- It cannot be stressed enough how important it is to be extremely thorough performing this task.
- Work your fingers into every centimetre of the edges and the rebate to guarantee there is absolutely no possibility of any bubbles of air being trapped.

CASTING THE DOOR AND WINDOW FRAMES - continued

The images below are of a different job and althoigh the door mould is the same dimensions the window mould in this case is for a smaller window. However, the procedure and method are the same as discussed.

A layer of render is placed in the base of the mould. Using the tips of your fingers throroughly work the render into the corners of the mould to expell any air bubbles. The first basalt fibre rebar is placed in position.

The first basalt rebar is covered by another layer of render.
Again, use fingers to compress and pack the render down

The next layer of render is placed into the mould

CASTING THE DOOR AND WINDOW FRAMES - continued

The door and window frame moulds are poured and have been left to cure for 5 days covered with a plastic sheet to retain the moisture in the concrete for optimal curing.
NOTE: The frames have some small blocks screwed down to the bench at the corners to hold the the frame in place and prevent any movement of the moulds while we are filling the moulds.

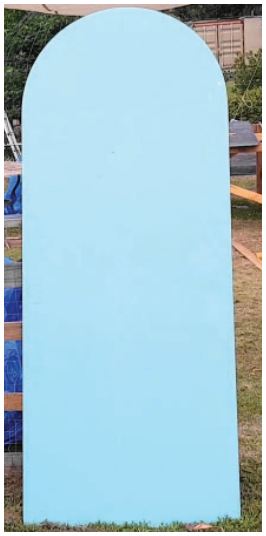
De-Moulding
When you come to de-mould the parts - be vary carefull - the door part in particular is susceptable to cracking if it is even slightly stressed.

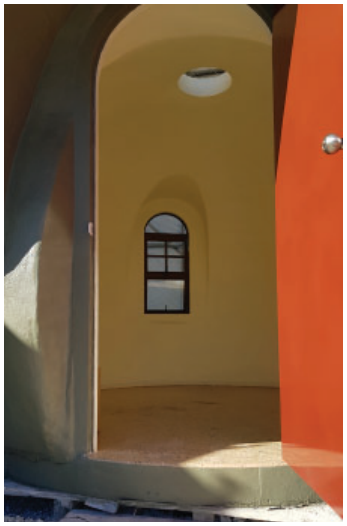
The mould is made in such a way that the outside parts of the mould can be separately removed and the inside parts of the mould can stay in place fixed to the supporting frame.

Remove only the outside part of the mould. The part together with the back and inside part of the mould can be lifted together when we go to instll the frames to the dome.eave the parts in the frame

ANOTHER EXAMPLE PRE-CAST DOOR AND WINDOW FRAMES

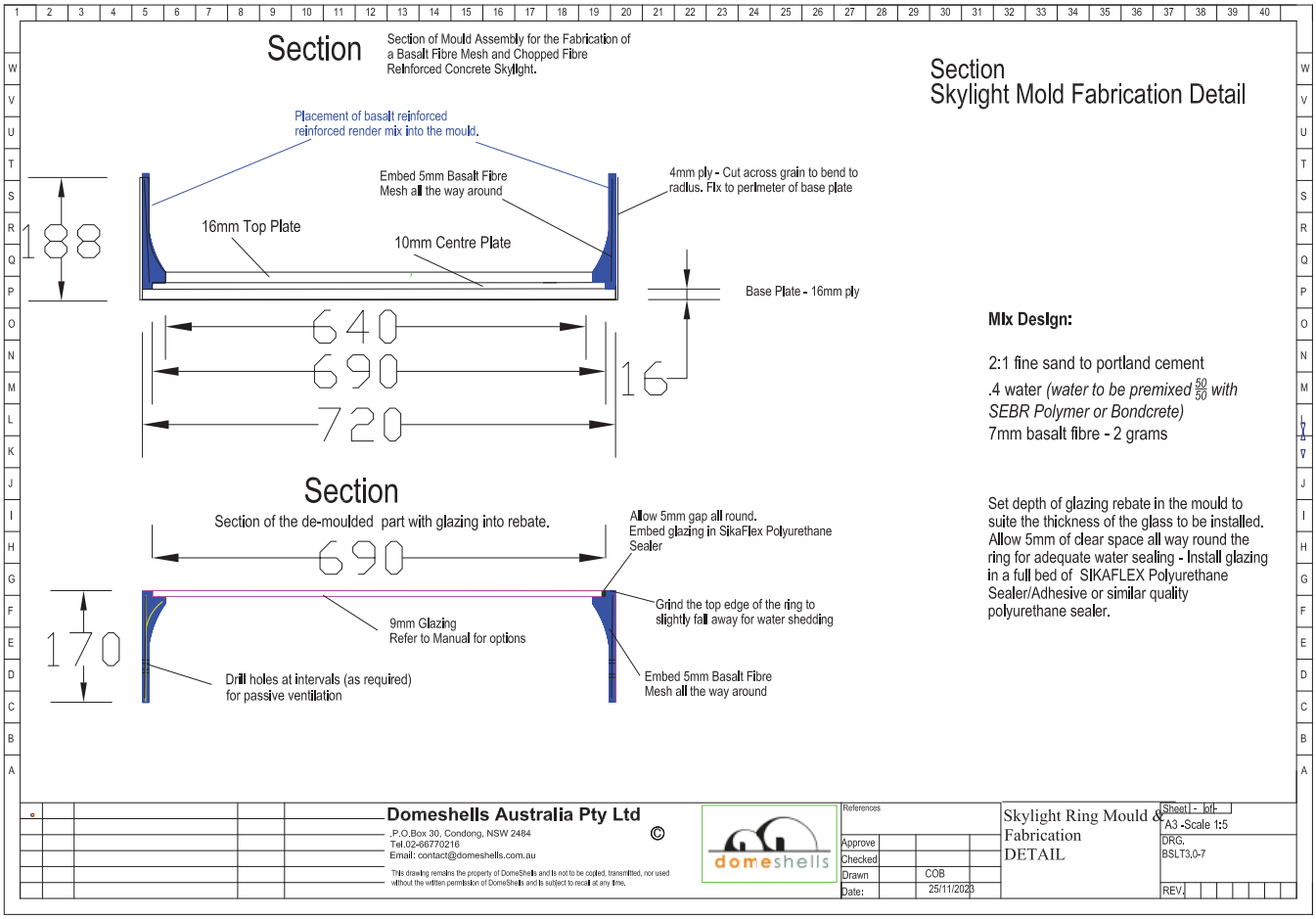
Below is another example where we used an old radius head aluminium window





FABRICATE THE SKYLIGHT RING
REF: DRAWING BSLT3.0-7

We always make our own circular concrete skylight for our hands-on workshops.
Using the high strength mix formula reinforced with basalt fibre and mesh.
Being concrete we want to make it as light as possible and so the ring we fabricate has relatively thin walls.
The drawing below shows a SECTION and dimensions of the mould and then below is a SECTION of the de-moulded ring with glazing.

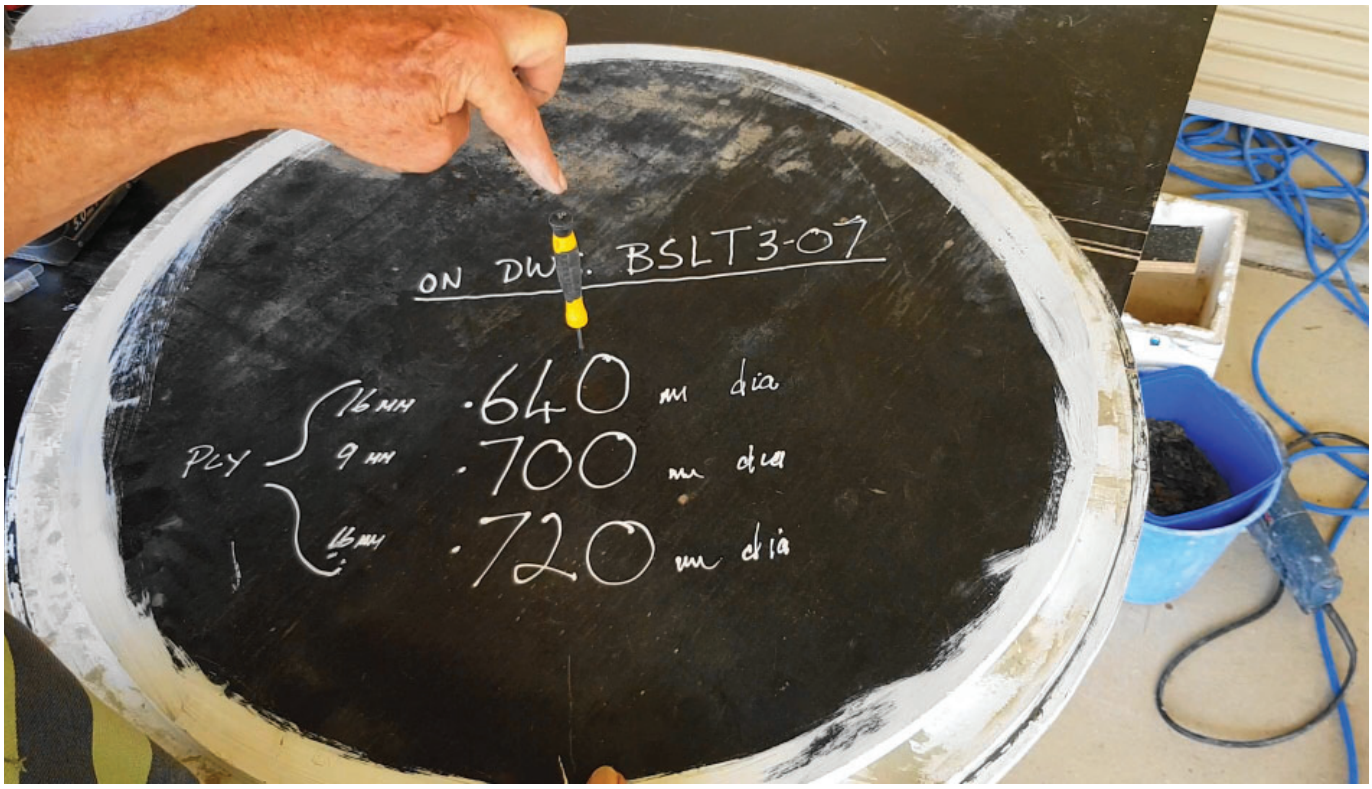


Make the Skylight Ring Mould

The mould consists of three circular plates.
The base plate is cut from 16mm-18mm formply - diameter 662mm
The other two rings are cut from9mm or 10mm ply - diameters 632mm and 592mm.
They are screws together forming a disk of three levels.
To the outer disk we fix an upstand of thin plywood to form the sides

FABRICATE THE SKYLIGHT RING - continued
REF: DRAWING BSLT3.0-7

The three plates are screw fixed together forming a sturdy base. The edges have beed filled, sanded and painted to ensure a smooth finish on the concrete when the ring is de-moulded.
A thin screwdriver penetrates a small hole that marks dead centre.



The three plates with the edges sanded and sealed.
Ready to fix the sides of the mould

FABRICATE THE SKYLIGHT RING - continued
REF: DRAWING BSLT3.0-7

Ready to fix the 4mm ply wood cut accross the grain for easy bending.

Make sure the sides are vertical at the join. It may be necessary to pull them together and apply some means of tieing them together. See next image we fixed plates at the join to tie them together.

FABRICATE THE SKYLIGHT RING - continued
REF: DRAWING BSLT3.0-7

IMPORTANT:

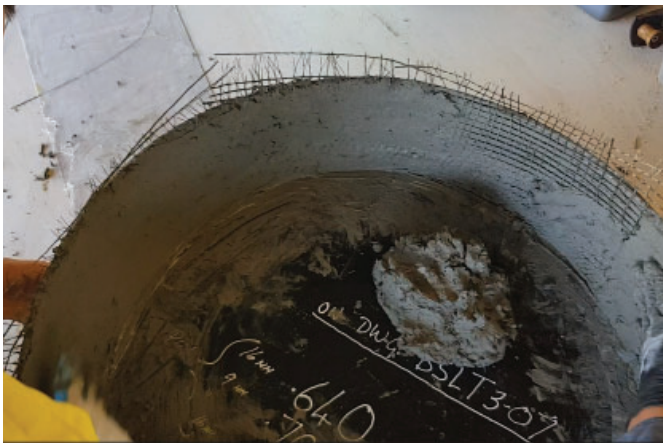
1. Paint the entire inside of the mould with a mould release prior to commencing the rendering process.. Almost any kind of oil is OK even canola oil. Wipe off any excess. It will make a BIG difference to the de-moulding process.
2. Thoroughly work the render mix into the corners at the bottom of the mould - Be VERY throuough and work it into every corner with your fingers

Sudents packing in the render to the side of the mould. NOTE: The mesh laid into the mix

Making a ring in the factory.

Making a ring in the factory.

Making a ring in the factory.



A few days later, the concrete is cured enough to carefully de-mould.

Strip the outside 4mm ply

CLEAN UP THE SKYLIGHT RING

When the side of the mould is released.
Lift the whole part up and with a hammer gently tap around the perimeter of the bases plate in a circular motion until the base plate fully releases.
If you ioled the mould before apply the remder mix then this operation should be smooth.


We intionally make the sides of the skylight ring higher than it needs to be so that we have plenty of extra length to be able to neatly cut it down to the height we need.

In the case we have marked at 120mm high and we cut all the way around on that line


A nice neat cut reveales the base of the skylight ring


The ring flipped over revealing the top of the ring and the rebate where the glazing will be fixed


INSTALL THE PRE-CAST APEX RING - Method One
It can be done in one of two ways.

From Here
We return to the dome cage and the installation of the pre-fabricated elements

Method One

- Using the pre-cast ring as the carousel mounted on the pole.
- The ring beam/hob is supported at the correct height on the centre pole.
- Three tight rings of 4mm basalt bar are tied to the starters in the ring.
- The vertical bars are tied directly to this hob/ carousel ring.

Below, the ring is upside down.

- The ring is supported on the pole by a 16mm circular plywood plate bolted on to the top side of the ring with a centre hole to slide over the pole and supported by the pipe clamp.
- This support plate could easily have been bolted on the underside of the ring

INSTALL THE PRE-CAST APEX RING - Method Two
It can be done in one of two ways.

Method Two

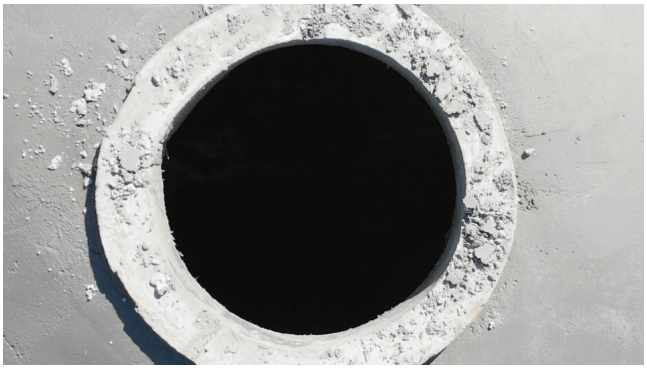
- Utilises the relatively lightweight plywood disk caoursel to tie the vertical basalt bars to.
- The dome shell is rendered to the edge of the carousel.
- It is then removed and the pre-fabricated concrete ring with starters installed can be placed over the opening and rendered into the dome from the outside.

- The first external skin of render is on, up to the edge of the plywood carousel ring.
- Clip off all the tie wires holding a bar to the ring.
- Carefully, with a hammer, tap the ring out through the top.
- Now the pre-fabricated hob ring can be placed over the hole at the apex and it can be rendered into the crown of the dome

The pre-fabricated ring is placed over the opening ready to be rendered into the dome shell

Placing a thick layer of render over the bars

When its finished - from above.



INSTALL PREFABRICATED DOOR & WINDOW FRAME

It is a good idea to complete all the prefabricated elements before starting the fabrication of the basalt dome cage if you want to continue the construction process seamlessly with the next stage which is installing the prefabricated elements into the dome cage.

The dome cage is finished!

- **From here you can complete the shell in 5 days with a crew of 5-6 people**
- **The door and window frames are ready.**
- **You have the role of 5mm basalt mesh ready.**
- **You are ready to start applying render.**

Lets Get Going!

This where we are heading.

Install the door and window frames in place and build the basalt framing of the hoods over the windows.. Get the first two levels of mesh fixed to the cage and start to get the first skim coat layers of render on the mesh.

INSTALL PRE-FABRICATED DOOR FRAME

Standing the Door Frame

The aim is to stand the door frame in place on the slab. We leave the inside and back part of the mould still fixed to a frame to maintain support for the door frame while it is being handled.

1. Some of the vertical bars and some of the horizontal bars will have to be cut away in order to be able to stand the door frame in place.
2. Cut away the minimum number of bars to be able to stand the frame.
3. Crefully manouvre the frame into place.
4. Check that the feet of the frame are exactly where they should be.
5. Using concrete anchors:

- fix small blocks of timber aganst the feet of the frame.
- Fix addional block to the concrete floor about 1.5m away from each leg. These are used to fix braces from the frame to the bround.

6. Begin by fixing the feet of the mould frame to the floor.
7. Take two bracing sticks/planks - one end fixed to the door frame and the other fixed down to ta block on the floor once the frame is plumb.
8. Ensure that the frame is securely fixed - plumb.

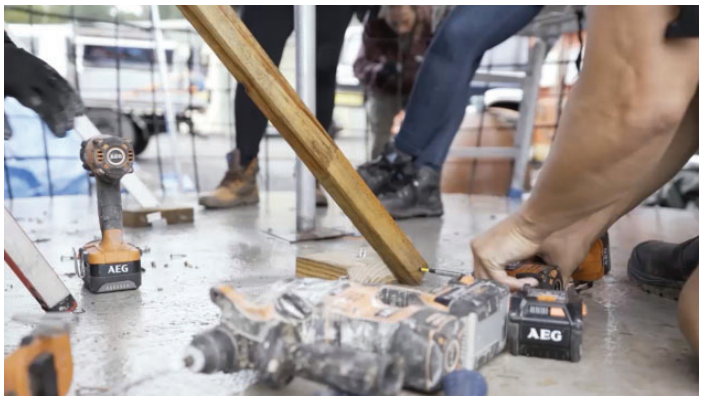
With the cast door frame still in its mould with support frame.

Carefully manouvre the frame into position at the doorway cutting away the minimum amount of bars possible.
The frame and outside of the mould can be removed when we have the frame standing in place.

INSTALL PRE-FABRICATED DOOR FRAME - continued

Ensure that the frame is standing plumb - each way

Pin wooden blocks near the middle of the dome slab to fix the bracing for the door frame



When the frame is fixed firmly in place it is time to design the hood over the opening.
How do we want it to look?
What shape?
It could be anything you want.

Pin wooden blocks to the slab at the feet of the frame to hold it in place

The door frame is braced in place - see the G clamps holding the timber brace to each side of the frame

INSTALL PRE-FABRICATED DOOR FRAME - continued

- The pre-cast door frame is pinned to the floor.
- It has two diagonal braces tied back to blocks pinned to the floor.
- It is exactly plumb in all directions

Now, it needs to be tied into the dome frameing.

To tie the door frame into the dome cage:
- Drill 7mm holes every 150mm into the side of the door frame all the way around - go about 50mm deep.
- Drill these holes carefully so as not to crack the door frame.
- Insert 200mm lengths of 6mm basalt in each hole so that all the way around the frame there are spikes sticking out about 150mm.

These starter/spikes get tied into the framing of the dome.

It's a little bit tricky at this point because the dome shape projects past the plane of the door and therefore requires a transition in geometry.

At this point:
Complete tieing the framing required to connect the door and transitions.
At the same time the hood geometry can be set up.

Maintain the horizontal and vertical bars around the doors as long as possible to hold the cage together.

INSTALL PRE-FABRICATED DOOR FRAME - continued

Here are a number of images from different angles and stages of the door installation and the hood constructuion and the start of applying mesh and render to the first 1.0m of the cage.

It works very well to get the first skim coat of render over the first layer of mesh up to about one meter high. By doing this, it considerably stiffens up the structures and makes it easier to fabricate the basalt rebar framing for the hood.

NOTE: The basalt rebar spikes sticking out of the pre-fabricated frame.
In the lower image you can see how they are tied to the hood framing

FABRICATE THE DOOR HOOD

A completely framed door hood

Completely framed door hood with 5mm GAL mesh fixed into the vally connection between the dome and the hood.
Now, we use 25mm basalt fibre mesh to reinforce intersecting connections.

NOTE: At this stage some of the horizontal bars are still in place.
It is important to leave a few horizontal bars in place to hold the body of the cage from sp[ringing.
Once there is at least one coat of render over 80 percent of the cage it will easily hold itself together.

INSTALLING THE PRE-FABRICATED WINDOW FRAME

Installing the pre-cast window frame is very similar to installing the door frame.

- The main difference is that the window frame is rectangular (in this case).
- It is more sturdy than the door frame.
- The window frame needs to be temporarily supported in place.
- We have constructed a timber stool that sits inside the dome on the floor to support the window frame in place at the correct height.
- We pin the stool to the floor to keep things stable.
- The frame is braced in place ensuring it is plamb all ways.
- NOTE: The inside of the mould is still attached to the window frame.

It is a good idea to leave the inside and maybe one other face of the mould in place to provide support and fixing to the frame.

Cut away the minimum amount of basalt bars to be able to stand the window in place, securely brace it in place and begin the process of tieing the frame into the dome cage and the hood framing.

FABRICATE THE WINDOW HOOD - continued

Creating the shape of the hoods is done in a similar way to the door.
The purpose it to create a connecting cage around the door and window that connectcta to the dome cage that we can then hang mesh on to.

With a layer of mesh and render on the lower 900mm of the dome.

Basalt Bars Around the Door and Window

The inserted basalt rods around the frames are to be connected in such a way that when all connected together the frame is held firmly in place and there are bars at all necessary places for the mesh to be tied to.

FIXING THE MESH

Reasons we use mesh

1. The mesh provides a means of applying and holding the first “skim coat” of render.
2. The mesh adds additional reinforcements to the shell.

We use two different types of mesh:

- **5mm basalt mesh** - the entire dome cage is covered with this mesh
- **5mm Galvanised mesh** - required only around the door and window hoods - (available from most hardware stores - only about 2m2 is required

Fixing the Mesh Procedure

1. Start by fixing a layer of 5mm x 5mm basalt mesh over the outside of the bars.
2. The mesh comes in a 1.0m wide roll
3. Start by unrolling a length all the way around the dome.
4. Place the mesh with the bottom of the mesh touching the floor.
5. **Start tieing the mesh to the bars at the widest part of the dome.**
6. In this case the widest part of the dome is at about 950mm above floor level so begin tieng the mesh at the top.
7. Use cable ties
8. Tie the mesh firmly and tightly.
9. Start at the door and work from one side around the dome.
10. The intention is to ensure the mesh is held taught around the frame.
11. Tie in such a way as to remove any baggy areas of mesh.
12. Fold the mesh below the diameter line to keep the mesh tight.
13. Do the same for the mesh above the diameter line
14. Use te cable ties to pull out any sag out of the mesh.
15. As you move down the width of mesh tie to the lower part of the frame.
16. The next layer of mesh must lap the lower layer of mesh by 150mm
17. All joins in the mesh must have a 150mm lap

FIXING THE BASALT MESH - continued

Pull the basalt mesh tight around the basalt frame.

FIXING THE GALVANIZED MESH

We use only a small quantity of 5mm Galvanzied mesh around the door and window for:

Additional reinforcing at the intersection of the door and window hoods to the dome to mechanically connect the two intersecting planes.
Additional reinforcing at the edges of the dome hoods. This also substantially assists in getting the first layer of render on the edges
Additional reinforcing around the door and window transtitions to mechanically connect all intersecting planes. Fold strips of mesh into valleys. Having the Galvanized mesh in these fiddly areas also helps to apply the first coat of render.

5mmx 5mm GAL steel snake mesh (in addition to the basalt mesh). Makes the application of render easier around the detailed areas. The render sticks on easier and creates a tougher reinforced concrete at critical areas like around mould forms and at the ends of hoods and and at joins of basalt bar reinforcing.

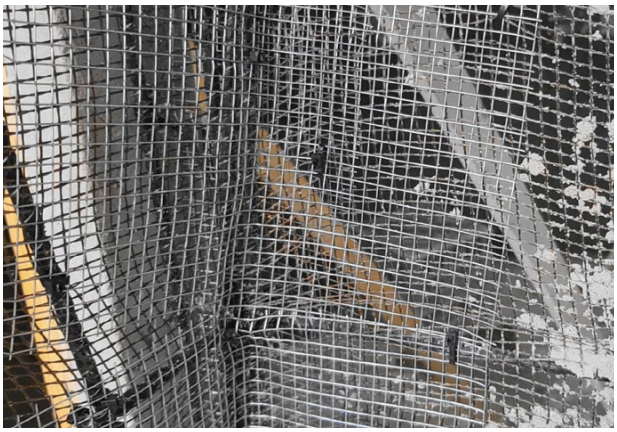
5mm GAL steel mesh in the corners of the valleys and around door & window frames
The steel mesh substantially increases reinforcement and connection around the door and window openings and also when laid in the valleys of the hoods.

Galvanized mesh is fixed to the edge of the hood and in the valley between the dome and the hood lapping about 150mm each side

We also fix GAL mesh to the transition area around the door for reinforcement and to make it easier to hang on the first coat of render.

FIXING THE GALVANIZED MESH - continued

CLose up of the Galvanized mesh fixing



Cut the GAL mesh with a steel blade on an angle grinder. It can also be cust with tin snips.

Fixing a layer of GAL mesh into the arch above the windowassists putting on the first ;layer of render.

FIXING 25mm BASALT MESH

The 25mm basalt mesh is an excellent material for using to connect intersecting planes.
It flexibility allows it to more easily conform to changing shape and planes.

In the images below we have laid both the 5mm and 25mm mesh over the hoods.
In particular, the 25mm mesh is folded out to the sides of the dome providing excellent reinforcing connection between the dome and the hood.

We preferr to use the 35mm basalt mesh for this purpose.

RENDERING OF THE DOME

APPLYING THE FIRST SKIM COAT LAYER OF RENDER

Considerations:

1. One drawback of the basalt mesh is that it does hold itself stiff. It needs to be tied taught over the frame for it to have any chance of holding the first layer of render.
2. The first coat is applied from inside and a sheet of fine (cotton) or plastic sheet is held against the outside of the mesh to prevent the render from pushing all the way through.
3. The render is dosed with basalt fibre which helps the render to stick onto the mesh.
4. The first layer can be extremely thin and patchy.
5. Even a thin and patchy 1st coat allows the next layer to grip on and hold.
6.

Render Mix Design

- 3 sand
- 1 cement
- 8 lit water (adjust to water content of sand)
- 1 cup of Bondcrete polymer
- 2 grams basalt fibre chopped strand

First mix the polymer in the water

The initial skim coat is rough with a very uneven surface - provides a very good key for the next layer.

The next layer of render over the skim coat could be from 5mm up to 15mm thick in parts where there are hollows and where gravity is not against you.

Rendering overhead can only be applied in thinner layers.

Procedure for mixing – mix in a bricklayers concrete mixer

1. Add the Bondcrete to the water and put into the mixer
2. Add sand
3. Add portland cement – (NOTE the cement can be grey cement, off-white or white cement depending on the colour you want – off-white and white cement are more expensive than grey cement.
4. Mix thoroughly for 5 minutes
5. Add the chopped fibre fibre slowly
6. Continue mixing for at least 2-3 minutes or until all materials are thoroughly mixed and the render mix is the right consistency.

Do not over mix once the fibres are mixed in so as to avoid fur-balling of the fibres

The Tools we Use

RENDERING OF THE DOME - continued

The First Coat is The Skim Coat.

- The Skim coat is the first coat applied to the mesh.
- The Skim Coat can be applied to the first round of mesh fixed to the basalt frame.
- Allow for the next layer of mesh to lap the first layer by 150mm
- The Skm Coat must be sprayed on. Due to the flexible nature of basalt mesh, it is almost impossible to get the render to hang on the basalt mesh by hand trowel.
- Use the render mix specified for the spray on render.

- Spray the skim-coat from the inside.
- Hold a sheet of materil fabric (almost any kind) against the mesh. This prevent the render mix from blowing straight through the mesh. The fibre in the render mix will help it to attach to the mesh.
- Only a very light coat is required.
- If there are patches on the mesh that are not fully covered it does not matter at rthis stage.
- Only apply the skim coat up to head height.
- After about 1.8m above the slab, the render has gravety working for it and the first coat can be a hand applied render.

RENDERING OF THE DOME - continued

Using a “render sprayer” machine

The small hopper render sprayer that we use is one of the best methods of getting material on the wall.
There are some stages through the job where using the render spray to apply the render will be much easier and efficient than trying to do it by hand.

The render sprayer works best when a team of three or more are working together. One person mixing, one spraying and one trowelling the sprayed on render.

In some cases the sprayed material may also entrap air - always trowel over the sprayed layer to remove entrapped air.
Available at:
www.rendersprayer.com.au
https://shop.domeshells.com.au/

In this image, the door and window frame are installed in place - note the braces down to the block on the floor holding the frames plumb.
The first roll of mesh has been fixed to the basalt frame.
The first skim coat has been sprayed up to the height of the first roll of mesh.
The next step is:
continue fixing the next roll of mesh up to the next level.
Spray a skim coat over the higher layer of mesh.
Apply (spray or hand trown) over the skim coat

APPLYING LAYERS OF RENDER

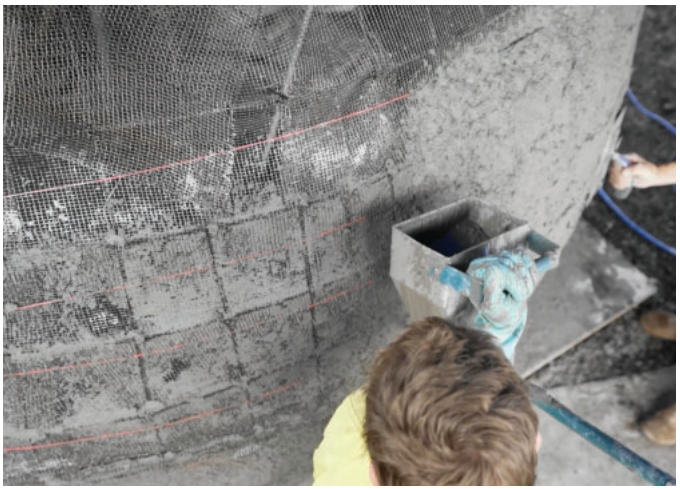
The image below illustrates the difference between a Skim Coat and the next layer on the lower level.
The lower level has a full coat of render applied over the skim coat by the render sprayer and then trowelled to compress the render.
Two more coats of about 10mm thick to go.
On each layer of render - trowel the sprayed layer an fill the hollows (low spots) with render
On top of the skim coat - apply three full layers to achieve the required thickness.
Three full layers are equal to about 30mm in render thickness
Full render coats are applied to both the inside and outside of the dome.

The inside of the dome can be sprayed (or hand troweled) any time after one full coat on the outside.

From around head height it is no longer necessary to spray the first skim coat.
From about head height the render can be place directly to the mesh and carefully spred to form the first layer.

APPLYING LAYERS OF RENDER - continued

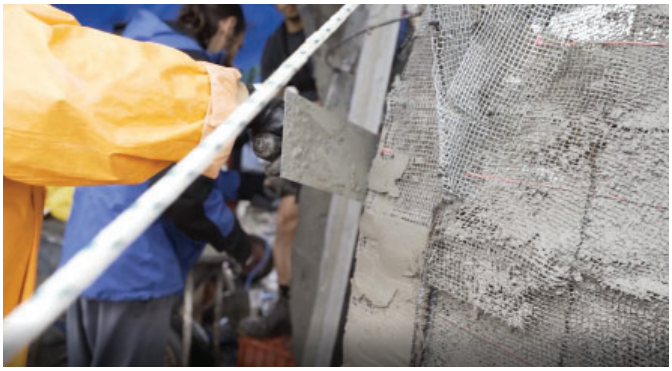
Mesh is fixed up to about 1.8m high. Layers of mesh still need to be fixed to to top of the dome frame and lap the lower mesh by 150mm.



After the first two layers of mesh the curvature of the dome allows render to be carefully applied by hand trowel.
The render will apply thicker than spraying.
Do NOT over trowel this stage

Gently applying render to the hoods by hand trowel

Applying render around the door by hand trowel



APPLYING LAYERS OF RENDER - continued

The rendering continues layer over layer

The internal layers can be applied as soon as the second external coat is applied.

NOTE:
The skylight opening with the bare bars. Here we have removed a timber disk carousel. In this case the hob ring is installed at the next stage

Rendering around the window sill inside and poutside requires quite a lot of render to fill the voids.

Hand pack the render under the sill in layers.
Shape under the sill to suite.

Externally is is necessary to frame up and render a sill under the window.

The inside has deep cavaties between the bars.

Focus the application of the render into the cavaties and low spots and trowel finish

RENDERING THE DOME- NOTES AND TIPS

Some Golden Rules

1. When applying render or plaster of any kind. ALWAYS - Focus on filling low spots and voids when applying the subsequent layers - you are aiming for as smooth even shape as possible. When you focus on filling the hollows you will end up with a better result.
2. Before starting a next layer - go around and knock off any high spots or lumps sitting in the previous layer. These will only make it more difficult by creating a high spot that you will need to deal with later.
3. Always ensure the substrate has a good key - it's only the final coat that needs to be polished.
4. Always ensure the substrate is damp before applying the next layer.
5. NEVER - use brick-layers plasticiser in the mixes for Domeshells structures (it acts contra to the polymer and very significantly weakens the concrete.

By the third layer most of the serious low spots should filled the surface is looking relatively even.

Building up the INTERNAL render thickness – by hand or spray machine

1. Looking from the inside at the back side of the the skim coat you will notice it is very rough. The bars are still exposed and the mesh may have sagged a bit in-between the bars.
2. Start rendering from the base. At first it is quite easy until the dome starts to curve inwards
3. Applying render to the inside of the dome is more difficult especially when applying render overhead.
4. It is a lot easier to apply a thick layer on the roof of the dome than the ceiling inside where additional layers will be needed to achieve thicknesses.
5. Application of subsequent coats can be applied by hand trowel or can be sprayed if you have a spray machine.

Applying render around door & window frames by hand

Hand render mix – is just a thicker version of the render with twice the usual amount of basalt fibre – two cups
In some locations, especially around the door and window installations, it is difficult to apply render with a trowel or a spray machine and may need to be applied by hand. Do not try to pack in too much in one place as it cvould fall out due to its self weight.

In spaces around the door and window castings where the only way to get the render into the space is to squeeze it in or push it in by hand or fingers.

When hand packing render into tight places it is critically important to be extremely thorough about using your fingers to push the material right into the corners and edges. Failure to do this well results in air cavities which then become extra work later on.

Thermal shell – application & thickness
Over the top of the structural concrete shell we apply a layer of lightweight concrete made with cement and perlite. The density of the lightweight concrete is approximately 600kg/m3

Voids in the Render
It is important to ensure there are no air pockets of air bubbles or voids in the shell.
Some tight areas around door and window opening may require packing render material by hand in which case care should be taken to ensure the material is well packed in.

Generally, the pressure applying render by trowel and subsequent passes with the trowel over the material will express any locked in air bubbles

THE BOND BETWEEN LAYERS OF CONCRETE (RENDER)

Maintain integrity of the bond between 2 layers of concrete (render).

Key-bond between layers

1. The substrate layer must be rough enough to form a key for the next coating.
2. When applying the initial layers it is naturally quite rough.
3. When rendering over a relatively smooth surface it should be scabbled (roughened) to form a key.
4. Sometimes it is necessary to physically create a key in fresh render by scratching the surface while still soft to form a key for the next layer.

Moisture and Hydration

1. Concrete and render will be weakened if the moisture is removed too fast.
2. It is very important through the construction process to keep the render moist at all times.
3. NEVER render over a dry substrate.
4. Always drench the substrate and apply the next layer when the water has soaked in.
5. 7. Keep the substrate damp (not wet but damp) especially important in hot weather and direct sun. This means having a hose on hand.
6. When the shiny wetness has been absorbed is the ideal time to apply the next layer.
7. Create a shade system over the dome to keep the sun off during the day.
8. Sometimes it may be necessary to wrap the whole dome in a tarpaulin.

When concrete is old and smooth and you are concerned about a key - paint with a polymer solution "Bondcrete" is designed as a bonding agent. Mix cement, water and polymer into a slurry and paint over a wetted surface before apply the next render coat. The slurry will increase the bond strength between to layers.

Curing the concrete

Keep new concrete render shaded and moist for at least 7 days after the last coat.

Thin layers of render can loose moisture through evaporation from the atmosphere or by a dry substrate – either way the rapid, excessive lost of moisture will make weak concrete.

Concrete needs water to form the chemical reaction that turns the sand and cement into concrete. Excessive water in the mix weakens concrete.

There is an optimum water content of the concrete to begin with and there is an optimum level of moisture retention in the concrete to enable the cure process to do its thing.

INSTALLING A GALVANIZED MESH HOB RING

Method One - Fabricating a hob ring using a wire mesh ring and hand rendering the ring at the apex

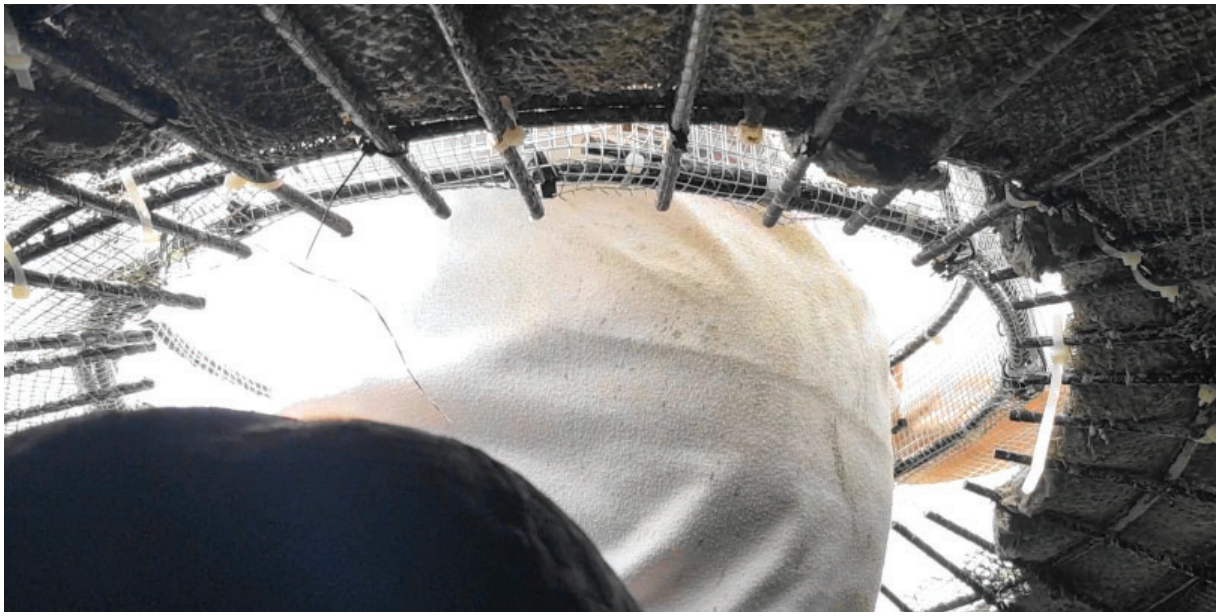
- With this method we have fabricated a ring from GAL mesh.
- This ring comprised of at least two layers of GAL mesh folded and tied together.
- The diameter is 500mm so that it will sit at the centre of a 100mm wide hob.
- The ring has is tied into the end of
- Here, a thick coat of render is applied all the way around to embed the surrounding mesh.
- The render is now brought up the side of the ring.
- Care should be taken to ensure that the render is pushed all the way through the mesh ensuring to air cavities.

It starts with the clipping of the wires holding the vertical bars to the carousel and gently tapping out the carousel with a hammer

The render material is built up around the mesh from inside and outside and finished with a trowel.

INSTALLING GALVANIZED MESH HOB RING - continued

In this image you can just see the GAL mesh ring sitting on top of the ends of the bars.
It is essential to allow a continuous aprin of mesh that extends into the dome to make a well reinforced connection.

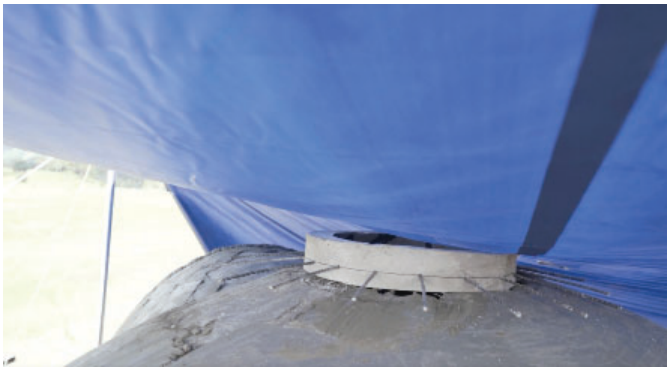


The ring is hand rendered with a trowel

A thin sheet of plastic around the hob helps smooth it off, keep it circular and allow for taking a level

INSTALLING PRE_FABRICATED SKYLIGHT OPENING HOB RING

Earlier lessons covered the fabrication of the skylight ring
The ring is laid over the opening and wired into the bars below and with a little extra mesh reinforcement around the edges.



The hob ring is rendered into the dome with up to 50mm of render at the highest point and then feathered off around the dome

INSTALLING THE PRE_FABRICATED HOB RING AT THE START

So, there are at least three different ways to fabricate the apex ring.

Installing a prefabricated ring on the pole is definitely our preferred method.

Reminder

The prefqabricated ring above is mouted on the pole.
To hold it in position:
We have fixed a 16mm formply disk to the top of the ring with short concrete bolts.
The disk has a hole at the centre to slide it over the pole.
WE can then use the pipe clamps we have fabricated to lock it into position.

All the verticals are tied to the caousel in the same way as if it was the plywood carousel.

Electrical Installation - continued

For electricity supply into the 3.0m diameter dome we we install a 15 amp caravan socket on the outside of the dome.
This allows electrciity supply to be plugged in by a lead from another power source.
Some regaulation may require a small distribution panel mountedon the wall inside or may require an RCD in the circuitry for electricution protection
Check with your local electrician what regulations and requirements apply to your project whever you are.

Decide the entry point for the Caravan socket input.
Lights, light switches and power points are powered from this point.

The power cables are contained in plastic conduit.
We install the conduit to the inside basalt frame before applying any render to the inside.
At each power point, light point and swithc pion we install and electrical box and connect the conduit into the box.

You may be allowed to install the conduit but you may not be qualified to install the wiring and connections.

Before you start the conduit - Consult an Electrician

1. Consult an electrician - recieve instruction from your electrician about exactly what you are allowed to do and how to do it.
2. Install a draw line into the conduit for puling cables later
3. Check with your local electrical supplier. There is a wide range of fittings for conduit including bends, connectors and boxes of various shapes and sizes
(a larger structure with permanent hard wired power supply it may require a mini board.

Maintaining structural integrity when installing conduit

1. Strap the conduit to the basalt rebar frame tightly so that it is rigidly held in place.
2. Strap the conduit to the frame before applying render
3. When rendering around the conduit ensure the render is packed well around the conduit
4. To compensate for the slight weakness caused by the conduit we build up the render an extra 20mm thick and embed a layer of 5x5mm basalt mesh extending 300mm either side of the conduit along its full length.

Options for electrical installation
Light and power points can be installed at any location.

Types of conduit
Check with your electrician about the best conduit to use.
We us both flexible corrugated conduit and regular conduit.- make sure to thread a draw string through.

20mm conduit connected to blocks of styrene foam to create a small cavity in the wall.

The top box (light point) is about 2.1m above slab level.

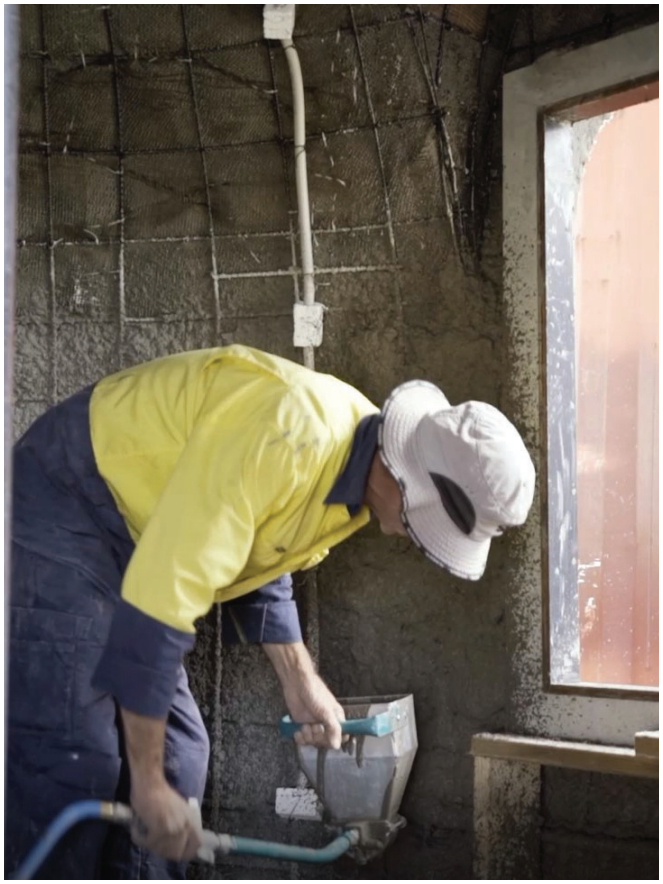
The middle block is located at the back of the external caravan plug socket - about 1.5m from ground level.
At this point will be the main junction box that sends power to the power points separately and the light and switch sepeartely. Over this box pouint is a swithc for the light.

The lower box is for the double power point

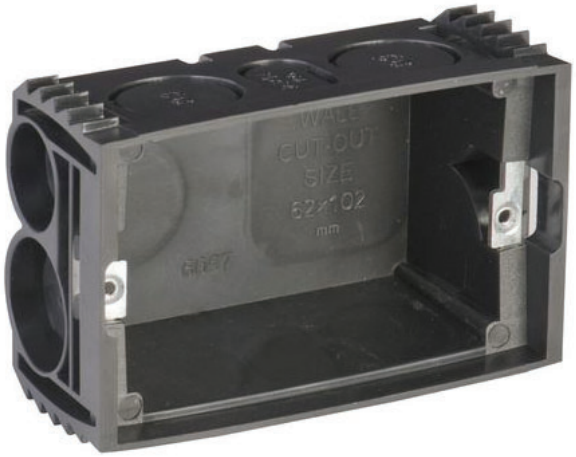
Electrical Installation - continued

The conduit must terminate in a box and be sealed against entry of render.
You can use a purpose made electrical wall box OR you can cut blocks of styrene foam that can be fixed to the basalt frame at the point of the wall box - whever there will be a plate with a switch

Typical plastic wall electrical box
with knock-outs for the conduit.
Tape over the boxes to prevent render entering



Flexable corrugated conduit



The 15 amp caravan power socket mounted
on the outside of the dome

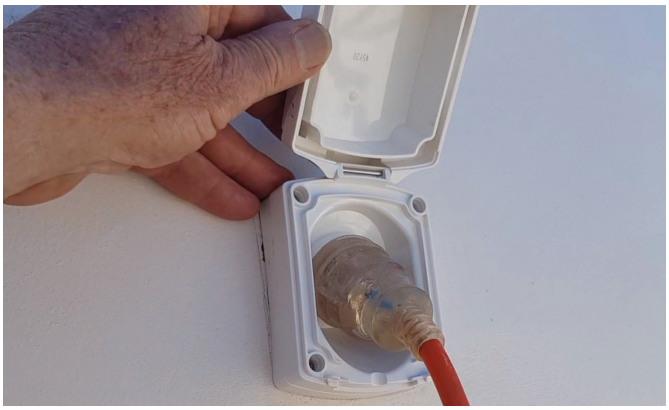
Electrical Installation - continued

In this case the box blockout was created by a blockof styrene. The stryrene block has been removed.
The rope is a drawstring to another box.
It is a good idea to insert a draw string as it makes it much easier to pull the electrical cables through.
The final coat of render has been applied and the electrician can complete the wiring.

The out side wall at the back of the blockout on the inside.
We have drilled a hole right through for the cable.
To fit the type of 15 Amp caravn plug that we have it is necessary to dig a hole in the shell to allow the caravan plug to fit

Chisel out the right size hole so that the plug fits flush against the shell wall

When all the wires are connect the plug can be screw fixed into the concrete usuing concrete plugs.



The cables are pullled through with the wires sticking out ready to be connected to the face plates.
The top wires are for a wall light.
The bottom wires are for a double power point.
The middle wires (at the back of the caravan socket outside, Will have a switch plate to operate the light.

FINISH THE FINAL LAYER FOR PAINT

- After applying the first coat of render the surface is quite rough and undulating with areas that are hollow or low.
- Each successive layer is used to smooth out differences by filling the low areas.
- It is important to go around the dome and knock off any tags, dags and lumps before applying the next coat.
- After 3 coats the surfaces should look relatively smooth with a finish of a trowel.

Spnge Finish

- To get the best finish on the final layer requires a "**SPONGE FINISH"** to the render.
- This literally means using a damp sponge to get a finer finish.
- To do this successfully the render must be at just the right point of setting.
- If it is too whet (green) the render will tend to move around (we dont want this)
- When the render is still very green but not set, is the best time to sponge finish the surface.
-
- With a large damp spong move in a circular motion over the render.
- Doing this smooths out any ridges and wrinkles, fills little holes and creates a smoother finish to the render.
- We finish both the inside and external shell using thsi method.
- This finish should be smooth enough to paint
- You can use any type of paint
- We generally apply a high quality acrylic paint to the inside and outside of the dome.
- **For the interior,** after three full coats of render the final finish coat can be a lime render.
- A thin coat of lime render applies very easily and it finished well with a sponge finish. Some people may even leave the finish this way and the walls become white.
- The external finish will be a finish over the lightweight perlite concrete and we will cover finishing this layer in more detail at the PERLITE section of the manual.

The images below a thin 4th coat of render has been applied specifically to concentrate on getting a smooth finish with a sponge

READY FOR EXTERNAL PERLITE THERMAL LAYER

The dome has now achieved its full thickness of 70mm plus. The structural shell is complete.
Ther is no sponge finish on this layer.
The next layer will be the perlite layer.

NOTE: The surface appears still a little uneven but we know that there is still another 30mm of light-weight concrete to go over the current finish and on that final layer we will finish with the sponge.

Around the edges of the hoods it still appears rough. At this point it is not a concern because once the thermal layer has been applied all the edges of the hoods need a final going over by hand to smooth off the edges and give it a neat appearance.

The perlite layer leaves a course grained finish. To fill the little voids in the surface and get a final finish on the outside, using a glove or sponge to spread, rub and polish to optimum smoothness.

LIGHTWEIGHT CONCRETE THERMAL LAYER

So far you have constructed a structural monolithic concrete shell that act as very good thermal mass but needs thermal protection on the external side to mitigate heat transferance to the structural shell.

The way we accomplish the thermal layer is with **"expanded perlite aggregate".**

Some types of lightweight insulating concrete?
There are many ways to make lightweight concrete. What makes concrete light is the entrapment of air in the mix or using a material with a very low density (lightweight). There are quite a few materials that can do that as listed below:

- polystyrene beads
- vermiculite
- hemp
- perlite
- scoria
- rice husks
- coconut fibre
- and probably other materials

Why we use Perlite (P400)
Our lightweight aggregate of choice is expanded perlite for several reasons:

1. it is readily available – from 100lit bags all the way up to 1m3 bags
2. its is very light -
3. it has very good air entrapment properties
4. it has excellent fire proofing properties – the best fire barrier against bushfire

Mix proportions for a perlite lightweight concrete
1 cement
5 perlite
half cup of SBA polymer.
The above mix produces a lightweight concrete of about 600kg/m3 (normal concrete is about 2200kg/m3).

Perlite – available from Domeshells or Ausperl
What is perlite
Perlite is a volcanic glass that is heated to 1,600 degrees F. (871 C.) whereupon it pops much like pop-corn and expands to 13 times its former size, resulting in an incredibly lightweight material. ... The super heated perlite is comprised of tiny air compartments.

PERLITE

BENEFITS OF PERLITE AND VERMICULITE IN FIRE-PROTECTION AND FIRE-PROOFING

- **Lightweight** - Weighs approximately 60% less than many sand products
- **Insulating** - 4 times more resistant to heat transmission than sand plasters... permits savings in heating and air conditioning costs... conserves energy.
- **Fire Resistant**- Non-combustible and non-toxic ... provides up to 5-hour fire protection with minimum weight and thickness ... more than 50 fire tested designs by recognized laboratories.
- **Noise Reduction** - Attenuates sound transmission between partitions.
- **Adaptable** - 100 liter bags or 1m3 bags in Australia. Easy to measure, mix and handle... job mixing permits proper proportioning to meet different plaster based materials specifications.
- Durable--Cannot rot or decay...strong but not brittle... endures freeze-thaw exposure... successfully used on major construction projects since 1946.

In the images below the external shell isin process of having a layer of perlite mix applied.

Around the crown of the dome it is easy to lay as thick a layer as you would like.
AS you come down the sides of the dome it becomes more difficult to lay on much more that about 15mm per layer.

WATERPROOFING THE SHELL

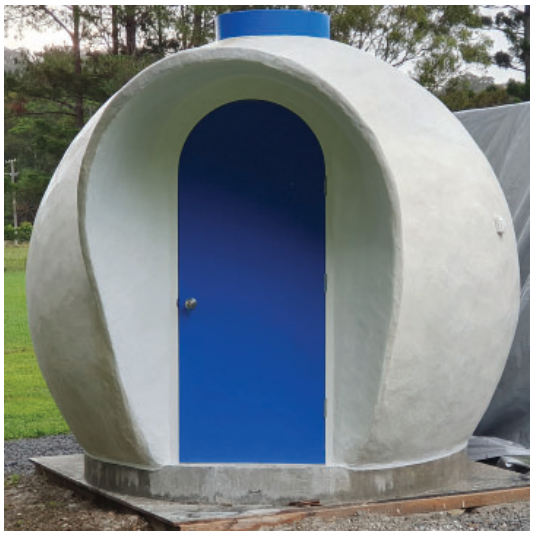
There are many concrete waterproofing products, different chemical formulations and application methods.

For the Domeshell we have found that the brand “Bondal SILASEC” to be a very simple and effective waterproofing system.

SILASEC is a cement based waterproofing system.
It is applied over the final finished concrete and before applying paint.

SILASEC is mixed with water and portland cement in the correct proportions and then painted on the surface.
The SILASEC formation creates a solution with significant solids that also work to seal and fill any tiny voids and pinholes. Follow the instructions from the manufacturer.
SILASEC is available in Australia in all Bunnings stores.

External finish is three coats of SILASEC mixed with white cement.



The dome below has had three coats of SILASEC and two coats of acrylic house paint

MATERIAL SUPPLIES

Materials

Common materials

The bulk of materials required for building a Domeshells can be commonly found throughout Australia and most of the rest of the world. They comprise of:

1. ready mix concrete - for footings and slabs and for shotcrete when building larger domes where using shotcrete equipment is cost effective.
2. sand - for the render/mortar mix used to construct the smaller domes
3. portland cement - used in the mix design of the render
4. additives - SBR polymer is the main additive to the render mix design
5. general hardware - nuts, bolts, crews, fixings, cable ties etc that are commonly available at hardware shops and builders suppliers.

Specialised Materials

Basalt reinforcing systems are not generally available yet in Australia.
Domeshells imports bulk quantities of a range of basalt reinforcing products:

basalt rebar - available in 100m coils or cut lengths
basalt chopped fibre - available in 20kg bags
basalt mesh - available in 1.0m x 100m rolls
6mm basalt braded rope - available in 100m rolls

We generally stock the common sizes that we specify in our structural drawings.

If basalt material packages are not available on our website at the time of reading, please contact us here: contact@domeshells.com.au and we will assist you with your order.

If you live outside of Australia please contact us and we will be able to refer you to an affiliated supplier in your country: contact@domeshells.com.au

Windows and Doors

Domeshells partner window and door suppliers are able to provide double and triple glazed windows and doors in aluminium and or steel for less than the cost of locally manufactured single glaze.

Depending on the specific sizes and quantities there could be lead times of up to 3-4 months for delivery please inquire: contact@domeshells.com.au

Pricing

We have not referred to pricing of any of the above as they are subject to international currency fluctuations that are becoming more volatile during todays uncertain times. We can quote for packages for your project at any time.

Please ask us.

DOMESHELLS SERVICES

For any of the following services please contact us at: contact@domeshells.com.au

Architectural Design Service

Bespoke design

Domeshells provides a complete bespoke design service for any client requiring their personal stamp on the architectural design and internal layout. A concrete shell structure could be almost any shape you can imagine.

Standard range designs

Domeshells range of standard designs are based on hemispherical geometry and a limited range of window and door opening sizes. We have to a great extent modularised our geometry in our effort to deliver the most economical design options for our customers. Windows and doors can be located virtually at any location around the dome and the internal layout is not restricted by the need for any internal support of the dome

Off-the-shelf-plans

We are developing a range of off-the-shelf structural plans that we have pre-engineered for wind loads up to category 5 cyclone. The off-the-shelf range will start with the 3.0m and 3.5m domes initially while we establish their viability and demand. We anticipate these designs to become available from late 2019.

Off-the-shelf-plans structural certification

The off-the-shelf- structural drawings must be certified by our engineer for the particular soil geology of your site and according to the local conditions. That means in order for you to receive an engineer certified structural set, you will need to provide a site plan and a copy of a Geotechnical engineers site soil analysis.
Once we receive this information from you, we will produce a set of certified drawings that you will be able to take to your local council.

Structural Design Service **(by our all state Australian registered, PhD qualified structural engineer)**

Domeshells engineers are experienced in designing compound curved shell structures utilising steel or basalt reinforcing bar. Although steel reinforcing is sometimes used in Domeshells structures the general method of fabrication is faster and easier with basalt rebar.

Building Services

Domeshells wide client base makes it impossible to stretch all over the country and beyond to provide contract building services.
We assist our customers by providing contulting to owners and builders and we assist owners in finding and qualifying builders capable and interested in our particular construction method.
In our experince an experinced builder will be able to pick up our method quickly and will only need some assistance with a few know-how issues. Many of these issues can also be satisfactorily dealt with via phone and video chat.

Building Consulting

We are able to place one of our experinced Domeshell builders together with a client owner builder or a licenced builder to consult for a period time to provide training and advice where required.

Training & Workshops

Domeshells runs training workshops periodically. (if you are on our mail list you will be notified whenever we schedule workshops in Austtalia or overseas)
We are expanding the distance from our base to provide 7 - 10 day workshops for groups where we build an entire dome from the slab to finish. Some of hose who have completed one of our workshops have gone on to build extremely ambitious and bespoke design dome homes and many have built their own small domes under the radar in back yards and on bush blocks.

Host a workshop

We will come to your location if you have the numbers for a workshop. Please inquire at the email above

