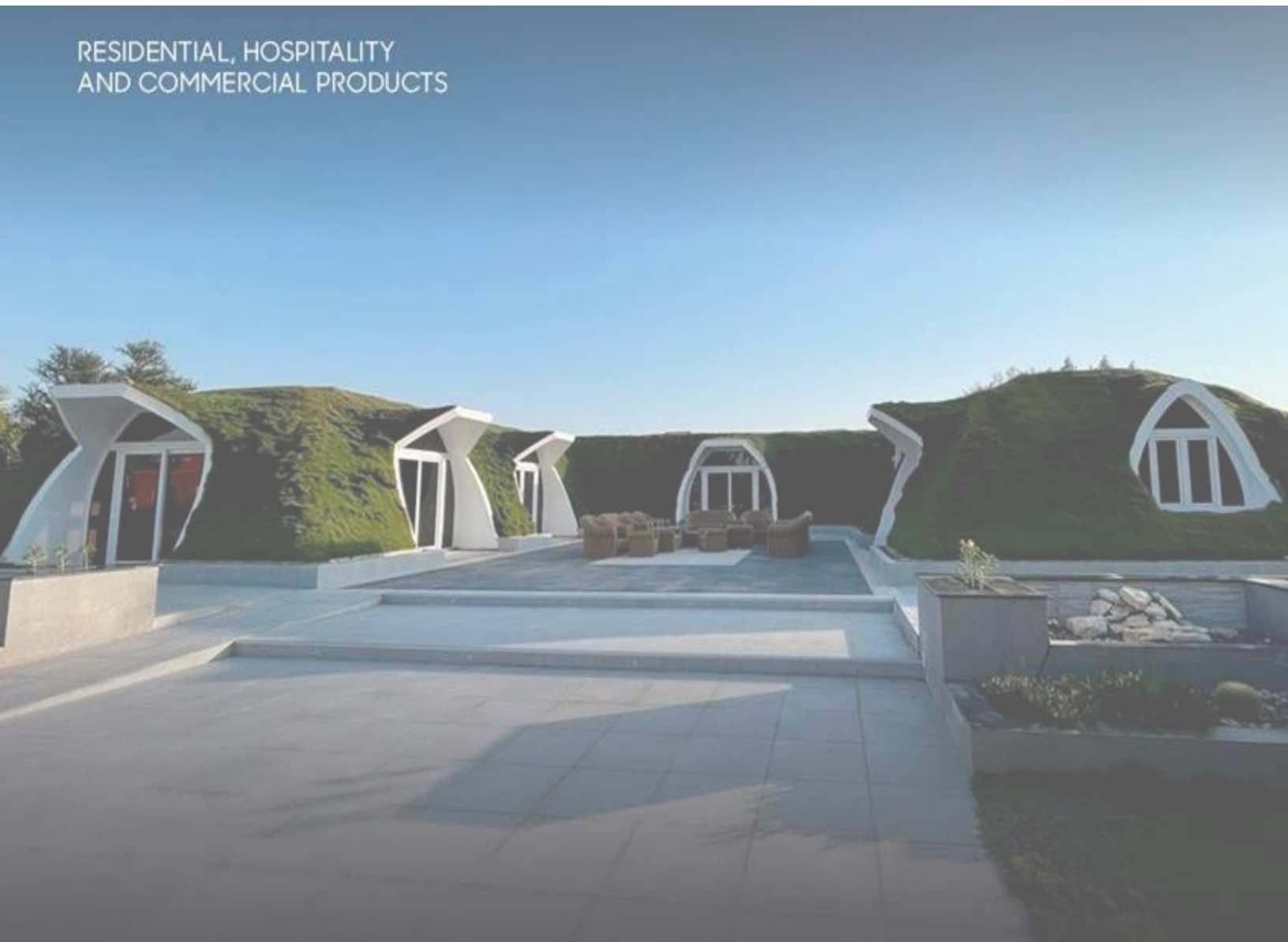


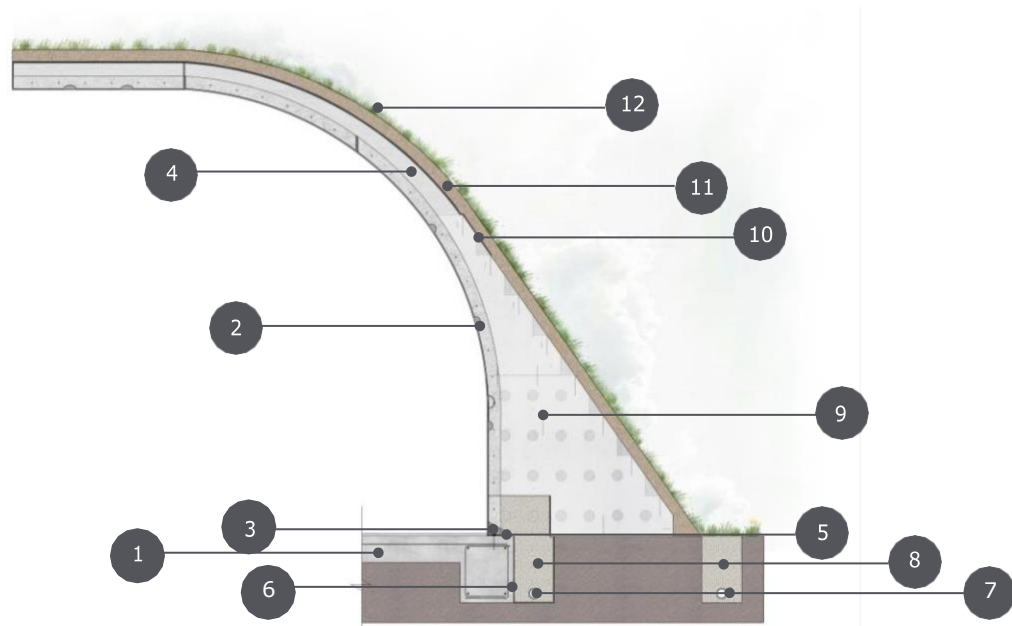
W.S.SYSTEM CONSTRUCTION MANUAL 2024

RESIDENTIAL, HOSPITALITY
AND COMMERCIAL PRODUCTS



W.S. SYSTEM

UNDERSTANDING OUR PATENTED EARTH- SHELTERED FRAMING TECHNOLOGY



Wonderful Structures is a patented and revolutionary construction system for Earth Sheltered Homes made with cutting-edge polymeric compounds and aero-space technology which offers the ability to live integrated in nature, with total comfort and high energy savings at very affordable prices.

Our “elevational” berm design layouts consist of an exposed elevation or face of the house, which usually faces south, to allow the sun to light and heat the interior, while soil covers the other sides and roof to protect and insulate the unit. The floor plans are arranged to allow common areas and bedrooms to share heat and light from the southern exposure.

The earth surrounding the house provides excellent sound-proofing, protects against the impact of extreme outdoor temperatures, requires less outside maintenance, blends into the landscape more harmoniously than conventional homes, and offers exceptional protection against high winds, hailstorms, and natural disasters.

The inside of the house is constructed to take advantage of solar gain and alternative energy efficiency, along with providing the convenience of traditional construction.

01. Foundation Slab
02. FRP component
03. Mechanical anchors
04. Polyurethane closed cell foam
05. Waterproofed Mortar wedge
06. Geotextile
07. Slotted drainpipe
08. Gravel or any type of granular soil
09. Retention Walls System
10. HDPE
11. Fertile soil
12. Grass

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01. INTRODUCTION



This manual lists the steps for proper assembly of a **W.S. Eco-Home**. These steps are required to ensure the smooth operation of technology and it's important that you follow them precisely. Nevertheless, the manual is only a guide for the construction process of the technology; attending the construction training course is required and essential for its correct development. Any change or modification made, that is not clearly expressed in this document, can cause serious problems for your project and **W.S.** will not be held liable for any claims in the future, leaving the company exempted from any liability.

Wonderful Structures guarantees the quality of the components and the stability of the technology at an engineering level, as described in the Structural Calculations Report, which is the reason why the steps described herein should be respected and followed strictly and rigorously.

The customer / technology buyer agrees that the company **Wonderful Structures**, shall not be held liable or penalized in any way for any damage that may occur to the structure or any accident that may happen to an operator during assembly.

It is the responsibility of all **W.S.** Certified Builders worldwide to follow the assembly procedures and methods herein strictly and rigorously without making any modifications that may compromise the structural integrity and quality of the final product and its compliance to construction codes.

Any damage or claim presented is subject to inspection of the structure to confirm that all instructions have been strictly followed as detailed in the steps outlined here.

In every build, it is the responsibility of the Certified Builder to follow rigorously the steps and techniques taught in the Certified Builder course along with the ones described within this assembly manual.

02. CONSTRUCTION CAMP AND STORAGE OF PRODUCT



The construction camp consists of properly installed tents whose function includes the management of the work, a camp for the workers, a collection center for the storage of materials, and a warehouse for the safeguarding of tools, and equipment, among others.

Camps should be in easily drainable sites and should not pose the risk of contamination with wastewater, latrines, and other waste, it should have all hygienic facilities properly connected to the sewage collection network. If this is not possible, a septic tank and an infiltration field should be constructed for the treatment and distribution of sewage.

Material collection centers or repositories are sites that need to be adapted at the project site to store materials that may suffer loss or damage from exposure to the outdoor conditions. All the products needed during the assembly and construction of the **W.S. Eco-Home**, such as polyurethane adhesives and sealant, epoxy bolts cartridges, elastomeric Ames peel & stick™ seam tape or bituminous sika multiseal tape, elastomeric or bituminous sealants, Epoxy paste Possehl Possalc 325 C20, polyurethane foam, fireguard E84 or Firefree88, primer and acrylic paints or any other product should be guarded from outdoor temperatures and weather conditions following each product data sheet specifications and maintenance instructions. As well as all the equipment that may suffer damage if it is exposed to outdoor conditions during the construction of the home.

The collection center must be provided with the appropriate space and facilities to store the equipment, materials and inputs required for construction, including those resulting from excavations that can be used later at the site. Stone materials such as slate, marble, limestone, granite and clay, or small grain rocks (sizes smaller than 0.001 mm), sand, gravel, gravel and other fine or coarse materials, should be confined and covered with polyethylene or any impermeable material to avoid dispersion and erosion by rainwater, run-off, and wind action.

03. ON-SITE WASTE MANAGEMENT

During the construction of your **W.S. Eco-Home**, and in accordance with our effort to be environmentally friendly the **W.S.** Certified Builders should implement the next management measures for the waste generated on-site.

Waste sorting point

W.S. Certified Builders must have an area designated for sort the waste generated. Usually, construction waste is classified by plastic, cardboard and paper, glass, wood, and other classifications that could be considered relevant. Lubricants, paints, fuel, aerosols, and other elements can be considered dangerous and must be properly classified.

The containers where the waste is deposited should be covered and clearly named for the workers.

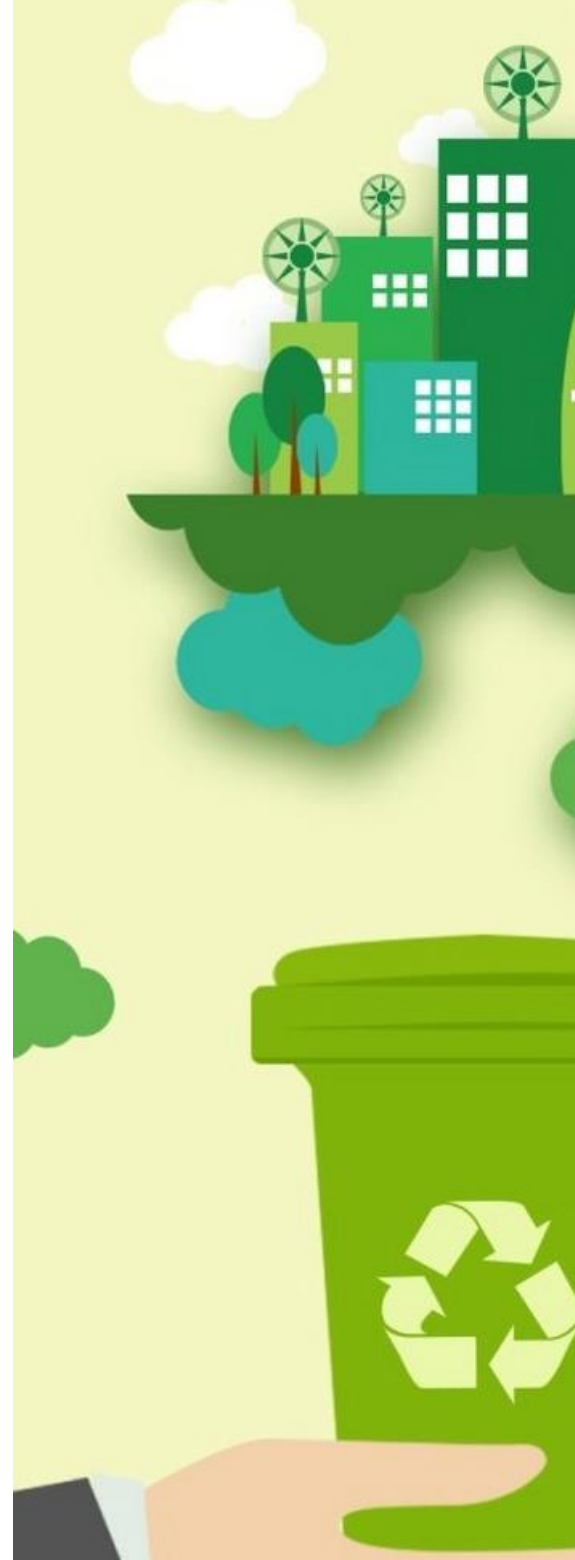
Constant cleaning of the generated waste

Workers on-site must collect all the waste generated during their activities such as product wrappers, water bottles, empty cans, leftover material, etc. This waste must be properly classified in the waste sorting point.

Organic soil storage

If the builder is planning to use the layer of organic soil that must be removed for the construction of the **W.S.** it should plan an adaptation on the construction site to storage and cover this organic soil to prevent the contamination on-site and also affect the working environment as little as possible.

The measures that were mentioned before would make a difference during the construction process, working on an organized and clean site.



04. UNLOADING AND SORTING OF PANELS AND PRODUCTS



When you have received the container, you should classify the pieces by the reference that identifies each component. The reference can be found in the component list added to the assembly guide.

It is important to take care of the pieces by covering them from the outdoor conditions as best as possible. Also, you should classify each construction product inside the camp taking care of the maintenance conditions for each product. specified in their datasheets.

It is important to avoid that the components are dragged or mistreated during their unloading and handling in the assembly process, this could blunt the corners of the module and affect the perfect finish made in our fabrics.

05. SITE CLEARING AND EXCAVATIONS FOR BASEMENTS (OPTIONAL)

ATTENTION:

These are just some examples of shoring systems that could be used, your local engineer or contractor must suggest to you the best option according to the local experience or soil characteristics.

Proceed to retire the vegetation layer of grass you have in this area, trying to conserve it as well as possible, so you can use it at the end to cover your underground shelter. For doing this, you may need a cutter mattock, wheelbarrow, rake, and shovel.

Afterward, you can begin excavating at the perimeter of the underground shelter delimitation. You may need a local geotechnical engineer or a contractor to correctly develop the temporary soil retention procedure according to the local requirements and statements.



Shoring systems are not standardized within North America or even within a single state of the United States. They are customized installations with variations depending on local experience, local conditions, availability, and materials cost.

One of the most common techniques used for shoring is trench boxes. These are steel fabrications that are introduced into the trench and dragged along with the excavation. The box configuration is such that it protects personnel in the trench and the work under construction from damage or injury caused by the collapse of the trench sidewalls. Trench boxes are designed to brace the two parallel walls of the trench against each other. The box walls are constructed from sheet steel, usually doubled, with a diaphragm between the two sheets to provide structural rigidity.

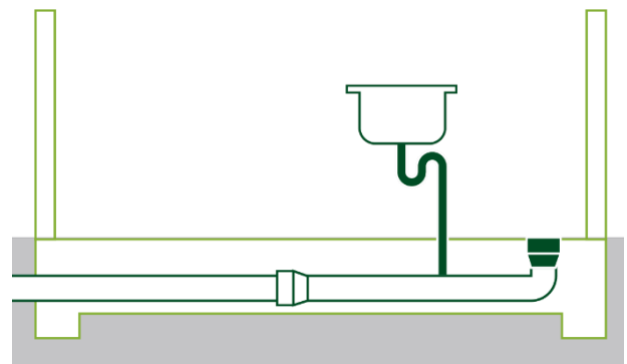
Another technique that could be applied in [W.S.](#) underground shelters with smaller areas is timbered shoring, which is probably one of the first shoring methods ever used. While it becomes quite cumbersome with depth and increased width, it can be a very economical solution for shallow excavations (less than 15 feet (4.5 m)) where the excavation sidewalls are parallel and less than about 12 feet (3.7 m) apart. The system relies on soil stability to permit the excavation of the pit. The soil must exhibit sufficient standup time to allow placement of bracing sets and vertical timber lagging. A typical timbered excavation would have a bracing frame made of 6 × 6 (150 by 150 mm) or 8 × 8 (200 by 200 mm) timber sitting directly on the bottom of the excavation. Another bracing set would be suspended somewhere close to the original ground elevation excavation. Vertical 2 or 3 inches (50-75 mm) timbers are placed side-by-side around the bracing sets' perimeter.

06. PLUMBING AND SEWAGE INSTALLATIONS



The water pipes and drains that carry water used for sinks, kitchen sinks, toilets and showers, and the drains thereof are installed the same way as in any traditional construction system, embedded in the foundation slab or under the sub floor. The pipes will form a horizontal network until they reach the point where they are connected to the plumbing equipment for drainage. To hide vertical pipe sections that would be covered by fixtures or furniture, gutters can be used for optimum presentation, of which many exist in the market today.

It is important, during the installation of the foundation, to have the plumbing installed by a professional. This will ensure that the work is done the right way while respecting and achieving the requirements and the building code of your area.



1 Water pipes and drains are installed embedded or under foundation slab, connected vertically with common fittings.

07. FOUNDATION SLAB

ATTENTION:

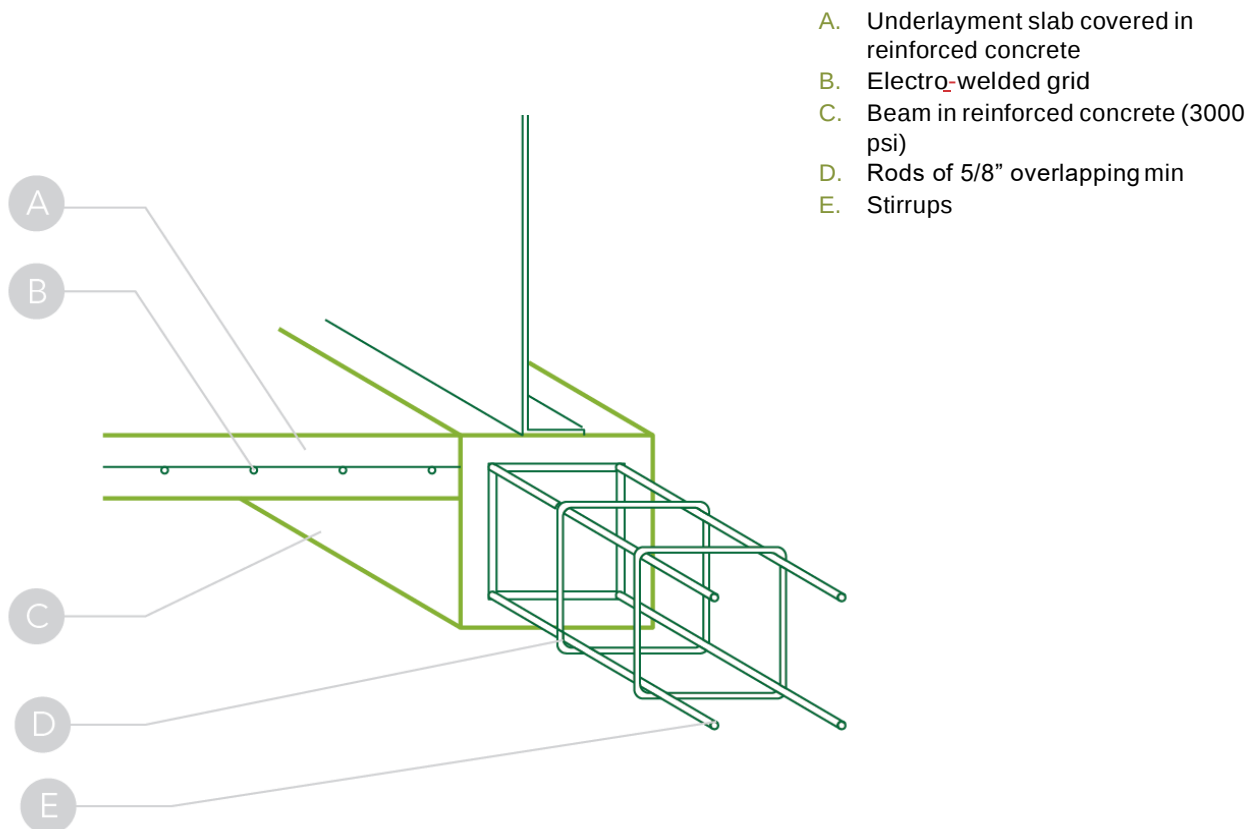
The mechanical expansive anchors included in our technology are thought to be anchored in concrete, so the slab should be considered concrete, or the client must look for another type of anchor not included in our package.

A W.S. structure can be anchored to any foundation built in compliance with local, national, or international building codes standards and should be built according to code requirements for your local area. We recommend the following as minimum requirements.

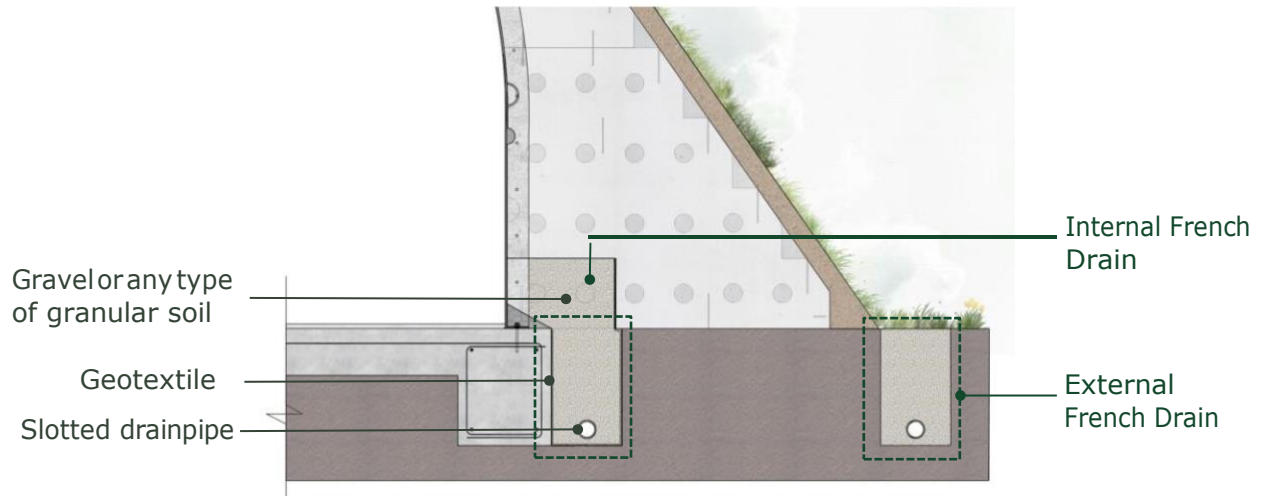
Initially, depending on the site's soil conditions, you must remove the top layer of organic soil to avoid the presence of a weak spot for the subsidence of the foundation. Unlike other buildings, this vegetable layer may be reused for the construction of structural bermed walls, along with technology. The foundations of W.S. Eco-Homes include a

leveled platform that allows the vertical construction of the walls of the building, bordering a completely leveled solid reinforced slab. This platform must be absolutely leveled, otherwise the assembly of the technology will be affected. Under typical conditions, the slab rests on the material subgrade (with $q_a > 1 \text{ kg/cm}^2$), the beam in reinforced concrete (3000 psi) along the same, overlapping at least 50 cm (19 7/10 inches), and with closed stirrups 3/8 inch every 15 cm (5 9/10 inches). The underlayment slab 10-12 cm (3 9/10 – 4 7/10 inches) thick is also covered in reinforced concrete (3000 psi) with a 4 mm (3/20 inches) and 15 cm (5 9/10 inches) electro-welded grid. Soil conditions must be verified by a geo-technical engineer, who may provide additional recommendations.

Make sure that the perimeter berm / terraces have sloping inclinations towards the outside to avoid rainwater getting inside your home.



08. RAINWATER DRAINAGE



ATTENTION:

The drainage depends on the type of slab needed on site. Usually, when there is an expansive soil, the slab is extended to the Retention Walls System and the internal French drain is avoided.

Each municipality has their specific rules when it comes to determining how much water can be drained from your property. A method that is commonly used is called the First Flush rule. The First Flush rule states that the first 15 minutes (or other duration determined by your municipality) of water from a storm must be stored on your property. Any water after that first 15 minutes can be discharged off your property. The reasoning behind the First Flush rule is that all the pollutants, fertilizers, oils, and other chemicals that are on the surface will be washed off in the first 15 minutes of the storm.

W.S. recommends installing two French drains as seen in the upper image:

01. The first one should be located next to the foundation slab; it will help drain all the water that may result from water leakage from the upside running between the R.W. System and the FRP components. This will prevent the water from entering the home and infiltrating the water into the land.
02. The second one is optional and depends on the land the client has on-site; it is a solution for the water that falls from the Sloped berm wall. This French drain helps the water to infiltrate into the soil, so it is not collected and concentrated in some parts causing foul odors. This drain can be constructed once the R.W. System is casted.

Next you will find general instructions for the construction of the French drains:

Planning and preparation:

01. Before building a French Drain, you must locate all underground cables, pipes, or other installations that could make digging dangerous in a part.
02. Check for any zoning or runoff issues. Some municipalities have rules on whether you can build or even dig on your own property. Speaking with the city and/or county officials and working together is in your best interest for this project.
03. Find a downhill slope with the level. To work well, your French drain needs to be constructed on a slight downhill grade. This allows water to drain away from the problem area through the force of gravity. If no natural downward slope exists, you can create a slope by digging progressively deeper as you work your way along the trench. It is recommended a 1-percent grade for the French drain to be effective. In other words, you should allow for a drop of one foot per every hundred feet of drainage (roughly one inch per ten feet of run).

Use landscaping paint to mark out the path of your proposed trench line, then use a couple of stakes, a length of string and a string level to gauge the incline from one end of the trench to the other.

Building the drain:

01. Dig the trench. Periodically check the depth of the trench as you dig, to ensure it is consistently sloping downwards.
02. Line the trench with landscape fabric. Once you have finished digging the trench, you will need to line it with the water-permeable landscape fabric.

Leave at minimum 10 inches (25.4 cm) of excess fabric on either side of the trench to ensure that you have enough fabric on the sides to fold over the drain rock, so it does not contaminate and plug the pipe.
03. Add the gravel. Shovel approximately 2 or 3 inches (5.1 or 7.6 cm) of gravel along the bottom of the trench, on top of the landscaping fabric.
04. Lay the pipe. Place the perforated drain pipe into the trench, on top of the gravel. Make sure the drain holes are facing down, as this will ensure the greatest drainage.
05. Cover the pipe. Shovel more gravel over the pipe, until there is 3 to 5 inches (7.6 to 12.7 cm) between the gravel and the top of the trench.
06. Fill in the trench. Fill in the rest of the trench with the displaced soil.



Please visit the next website for more information:

<https://www.wikihow.com/Build-a-French-Drain>

09. SANIFLO® PLUMBING TECHNOLOGY

ATTENTION:

This plumbing system is a suggestion to our clients, but it is up to the client to use it in their project.

Saniflo is the world leader in the plumbing industry because of the above-floor technology used in Saniflo pumps. They offer a wide range of macerating and grinding pump systems as well as drain and condensate pumps. Also, the innovative method of using above-floor technology allows the installation of any sanitary application you can imagine.

The technology of **W.S. Eco-Homes** can work either with actualized technologies such as Saniflo® or with traditional hydraulic systems.

Saniflo is just a recommended system in projects in which you have the following characteristics:



SanifloPLUS ®

01. The main network in which the hydraulic system of the home must be connected is 150 ft far away.
02. The pump moves the waste up or out the back of the unit, into the main stack of your plumbing. This is the functionality that makes it possible to install an up-flush toilet in a basement or any other room that is below the level of primary plumbing.
03. Projects in which the aim is to avoid the installation of systems underground because of expensive labor fees.
04. Projects where the ecological aspect is a priority.
05. While a traditional bathroom will take weeks to create, an up-flush toilet, with this technology it can be completely installed in just a day.

Saniflo® has a variety of products in which the choice will depend on the number of bathroom fixtures connected to the system and the capacity needed for the project. The Saniflo® system is easy and fast to install and can be hidden in the internal walls, offering an aesthetic finish and an efficient system.

Please, visit the next webpage for more information:
<https://www.saniflo.com/us/>

Please, inform the **W.S.** team if you want to include this system in your project, and we will advise you on the best way to fit this system into our technology depending to your project.

10. VARIABLE REFRIGERANT FLOW AIR CONDITIONING

ATTENTION: The HVAC system is not included in the technology; the client must select the system they will use. If the system involves cassettes, please inform the W.S. design team, Project Developer, or be aware of marking that option in the project form, so the team can include the components of the technology that cover the cassette by its outer side.

Variable Refrigerant Flow (VRF) is an HVAC technology that uses refrigerant as cooling and heating medium. It has been the VRF HVAC technology choice in Europe, Japan, China and other parts of the world and it has become increasingly popular in the US. Some of its benefits are:



Consistent
comfort



Quiet
operation



Energy
efficient



Installation
flexibility



Heat and cool
simultaneously



Zoned
heating and
cooling



Fewer
breakdowns/less
downtime

Instead of one large, noisy unit pumping out air to the whole space as in the traditional HVAC systems, a VRF HVAC system features several smaller air handlers that can be individually controlled and piped back to one system. The term variable refrigerant flow, or VRF, refers to the system's ability to control the amount of refrigerant flowing to each of these small air handlers.

VRF HVAC technology can provide not only cooling, but also heat, and even both simultaneously to different areas within the space. The use of multiple indoor units provides the ability to create zones that can be individually controlled. These VRF systems are very quiet and energy-efficient because the variable-speed compressor runs only at the capacity needed for the current conditions.

HOW DOES VRF WORK?

When the indoor temperature is programmed to the desired temperature, the VRF unit starts to work. To calculate how to create the optimal indoor temperature, the unit takes the outside ambient temperature into consideration. This is the defining feature of a VRF unit and what makes them so efficient. The unit will perform the calculation and only run the compressor with enough energy to meet the requirements of the indoor desired temperature. Additionally, if a secondary VRF unit is turned on, the system knows to perform another calculation. Now, to reach the desired temperature, the VRF unit considers the current ambient outdoor temperature, the contribution from a secondary unit, and the indoor temperature to create the desired indoor temperature most efficiently.

LG DUCT FREE SYSTEMS

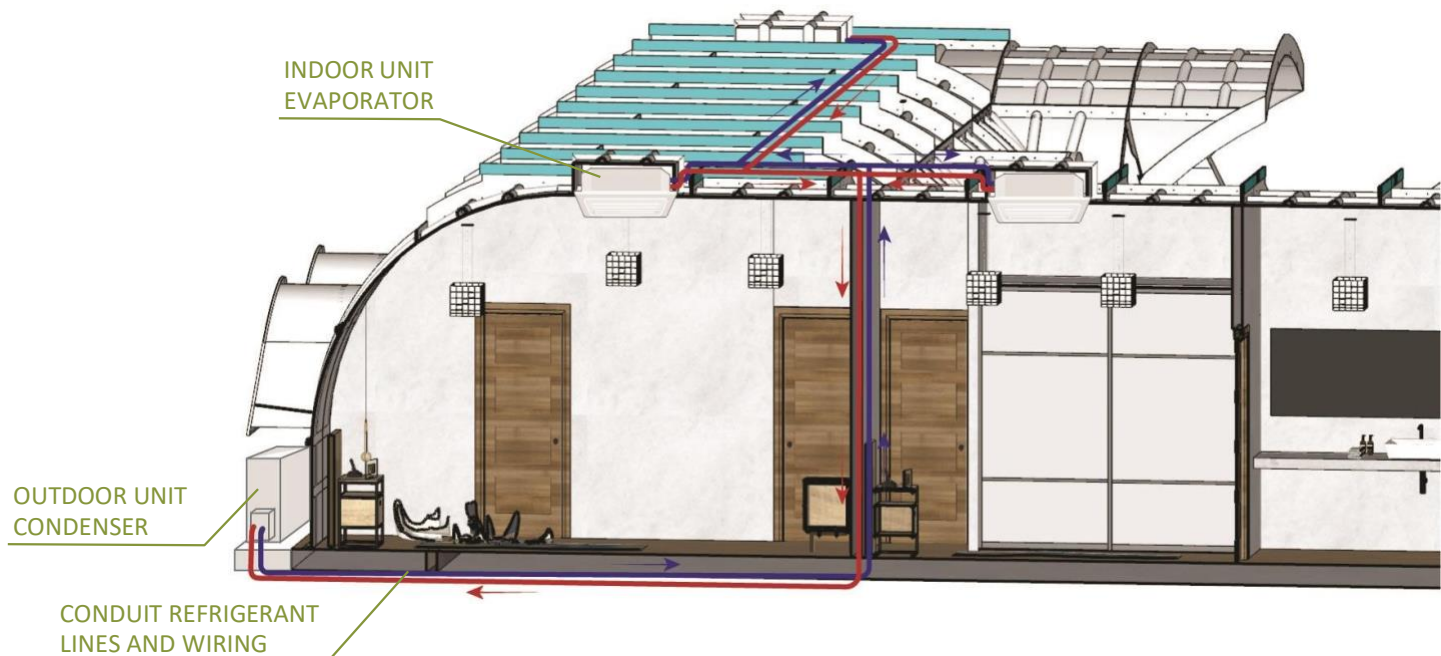
LG HVAC systems offer a range of solutions that are cost efficient, quiet, and attractive. Duct-Free Split (DFS) systems are “split” into indoor and outdoor units and provide a smart alternative to both central HVAC and window-mounted air conditioners. These inverter heat pump systems are available in a variety of configurations to suit different cooling and heating situations.

A DFS system is simply a reconfiguration of a traditional central air conditioner, consisting of an outdoor inverter driven compressor/ condenser unit, one or more indoor evaporator units, and a compact conduit for refrigerant piping and wiring. Instead of using one indoor evaporator coil / air handler to move cooled or heated air through ductwork as central air conditioners do, the indoor evaporator units are installed directly in each room. Because the indoor units deliver conditioned air directly into the room, the need for complicated ductwork is removed, and energy losses from air traveling through ductwork are reduced. And because each indoor unit has its own thermostat and controller, temperatures can be customized for each room. Installation by a qualified HVAC contractor is safe and easy – little to no duct work or sheet metal is required.

INVERTER IN-CEILING CASSETTE

As our [W.S.](#) fiberglass reinforced panels have a concave profile, this inverter technology becomes in the best solution that apports to the flow of the air from the cassette to the conditioned zone, giving the best energy efficient experience, low indoor noise, and comfort to our client. This profile avoids ceiling stains and improves the air current flow as it flows along the wall directly to the conditioning zone, completely improving the experience and comfort of the homeowners.

The system is composed of 3 units: Indoor, outdoor, and front panel. Also, it is possible to have a remote controller which features a large wide LCD screen and makes it easy for users to see and use the digital operating controls. If you select the cassette as your HVAC option, please report this to the [W.S.](#) design team so the component of family 48 is included in your order and your architectural plans are designed according to your needs.



OTHER HEATING SYSTEMS



HYDRONIC RADIANT FLOOR

Hydronic heating system, also called radiant floor heating, is a luxurious home feature and a popular trend in new housing, as well as in renovations that focus on clean, comfortable, design-led living. These use piping under a floor and are made up of flexible tubes that are filled with water or a glycol solution. These can heat any kind of floor, including concrete, and are an efficient method of providing warmth in a home.

Hydronic systems are attached to a hot water heater, a pump that circulates the water, and a thermostat to regulate room temperature. The system is closed, meaning it does not connect to the hot water heater and system you use every day for washing, cooking, and bathing.

ATTENTION:

If you are going to adapt this system to a W.S. construction, it is important that it **MUST NOT** interfere in between the slab, the anchor system specified in this manual and the modules. Our technical studies on the anchoring of the system consider the direct contact of the anchor to the concrete slab or foundation, any other layer in between this joint could affect the structural behavior of the home in face of horizontal forces. The hydronic radiant floor mats should be placed in the refining floor, inside the limits imposed by the components.



11. TOOLS REQUIRED FOR ASSEMBLY



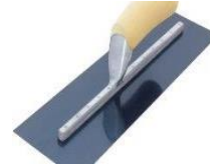
Safety Glasses
and protective
Gloves



Overhead Drywall
Lift



Measuring Tape



Metal Trowels



X1 Drill



Drill cup
(Diameter of the
nut)



Quick Clamps Or
Five Inches C-
Clamps



Dust blower



Caulking Gun For
Application of panel
adhesive



Assorted Length,
Steel Levels



X2 4' To 12' Ft
Adjustable
Ceiling Supports



X2 Rubber
Hammers



X2 Step Ladders 12'
Ft



A Ratch with Two
Piece Dice and
Spanish Keys



DeWalt 20V
Cordless oscillating
multitool

12. OPTIONAL TOOLS



Chalk line

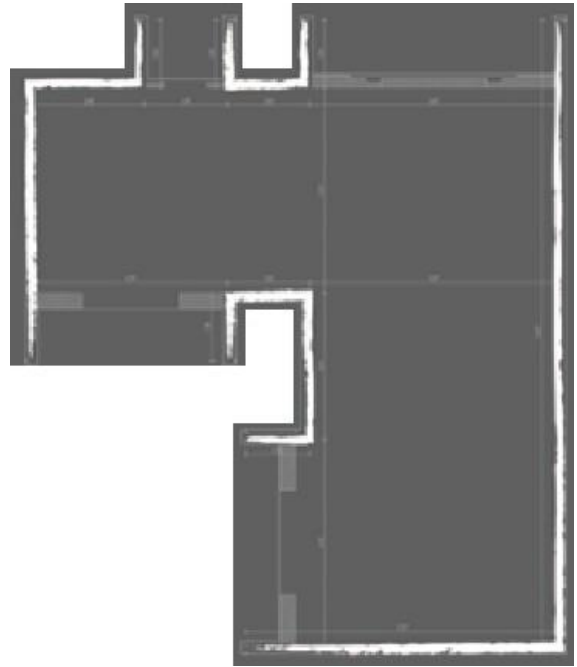


X1 Laser Level



Scissors lift

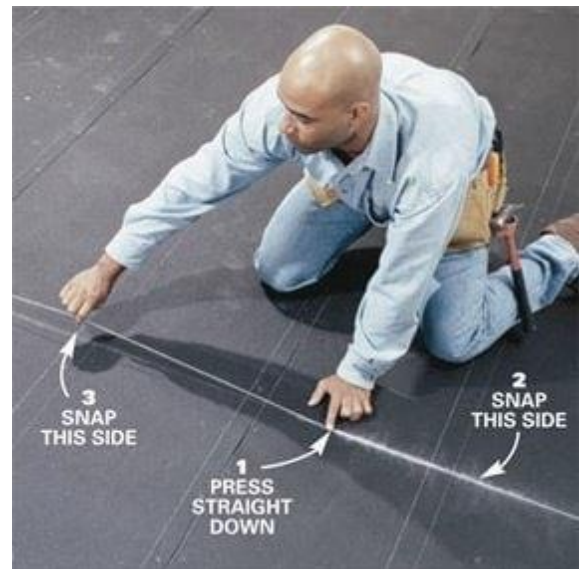
13. FRP COMPONENTS ASSEMBLY AND INSTALLATION



LAYOUT PREPARATION

The technology consists mainly of Structural Arches made of a fiber reinforced polymeric compound based on aero-space technology. The main material used for the technology is Fiberglass.

Before beginning, align the drawing of the architectural plans with chalk over the slab using the chalk line to achieve the most accurate measurements possible and to ensure that the components are assembled in the correct place. The interior flange edge of the component should be aligned with this drawing.



ASSEMBLY PROCEDURE

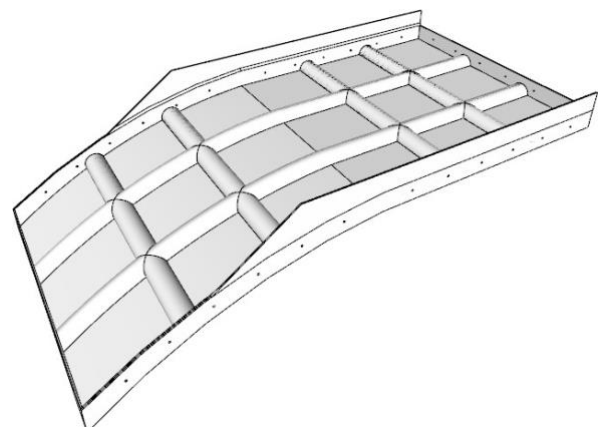
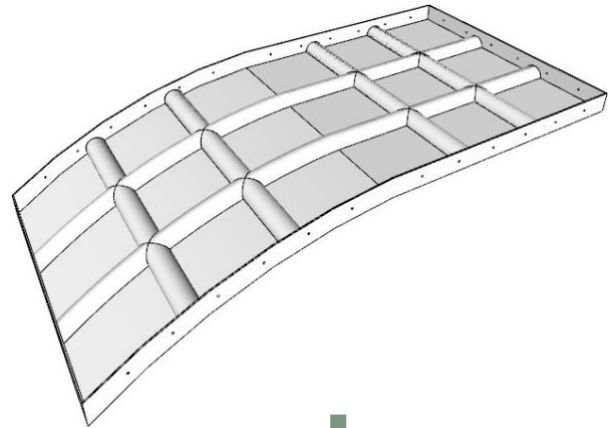
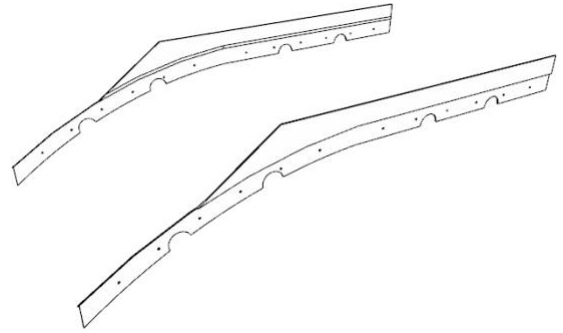
STEP No. 1

The dynamic fins are the fins of the component which are separated of the component from fabric to make the shipment more compact.

You have received the dynamic fins in the components of the families 27 and 45, so first you should paste the dynamic fin to the component using the Sikaflex or similar construction adhesive. Then, screw the fin in the component so that the fin is completely pasted. Finally, wait until the next day to unscrew them.

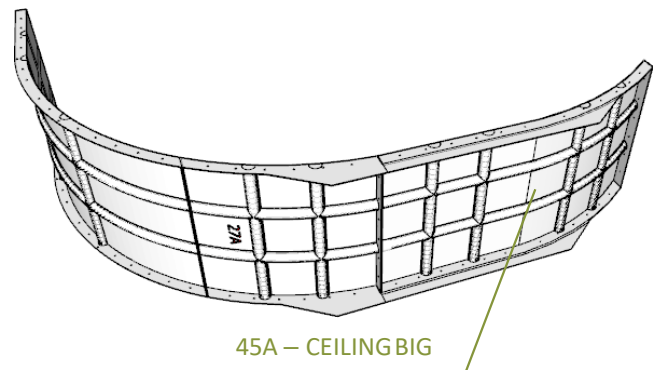
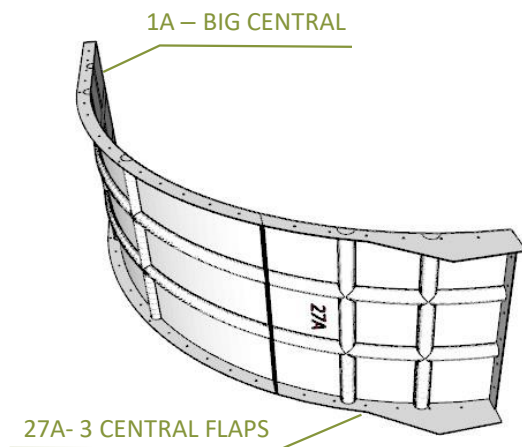
When you have assembled all the Dynamic fins in each component, proceed to assemble your unit using the Assembly guide included with your order.

NOTE: Not all models come with dynamic fins.



Then, lay the first module of the arch (BC- Big central) horizontally over the floor, following the drawing you have made. We are going to assemble the first arch lying in the floor and then lift it, so try to assemble it in the floor over the drawing you have made and follow the order showed in the assembly guide. To do this, please follow the next steps:

ATTENTION: Next is explained a general instruction for the assembly of the system. W.S. includes an ASSEMBLY GUIDE for each product, where the customer can find the correct assembly order of their model. Please take this chapter of the W.S. CONSTRUCTION MANUAL just as a reference of the correct way in which the components should be fixed.



STEP No. 2

Following the assembly guide, align horizontally the next component that is next to the big central. As an example, the image above shows the 27A (3 Central Flaps) ready to be glued with Polyurethane adhesive and secured with bolts and nuts next to the 1A - Big Central. Both components must be aligned and laid horizontally over the floor.

ATTENTION:

Do not secure the components to the floor with the anchors until having assembled the structure, as explained in the training course.

STEP No. 3

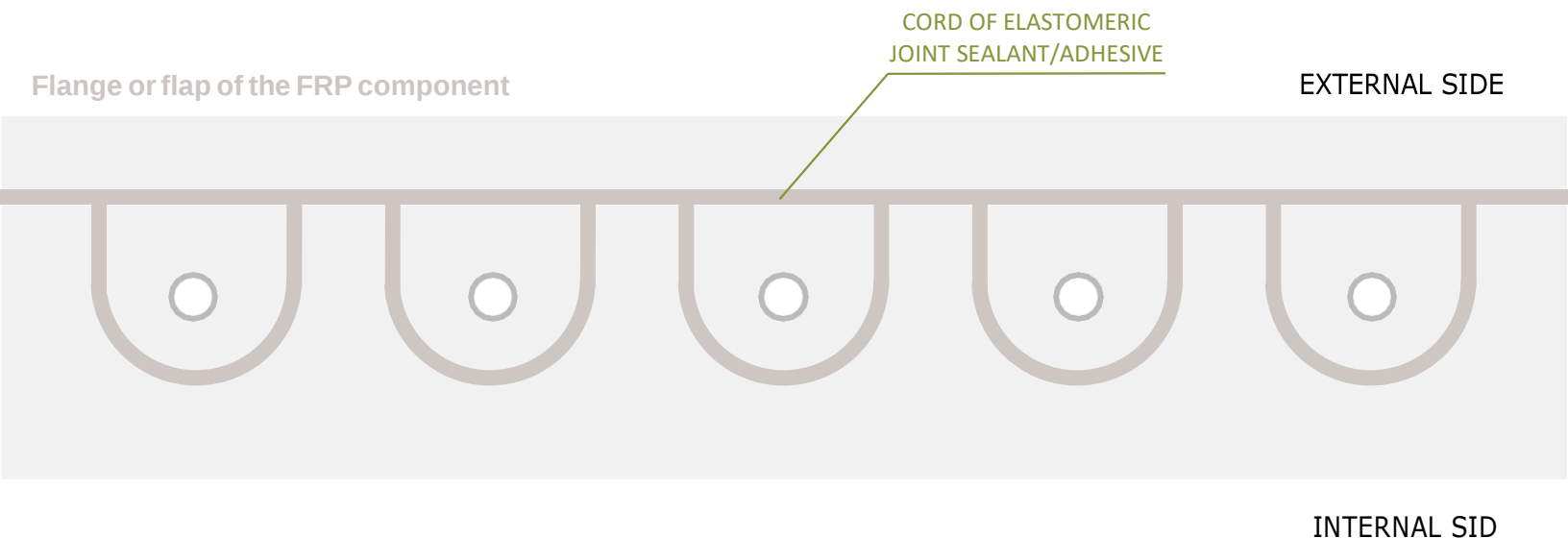
Align the component 45A (Ceiling big) next to the 27A just as shown in the image above. Then, secure them with polyurethane adhesive, the bolts, and nuts. Components should be laid on the floor yet.

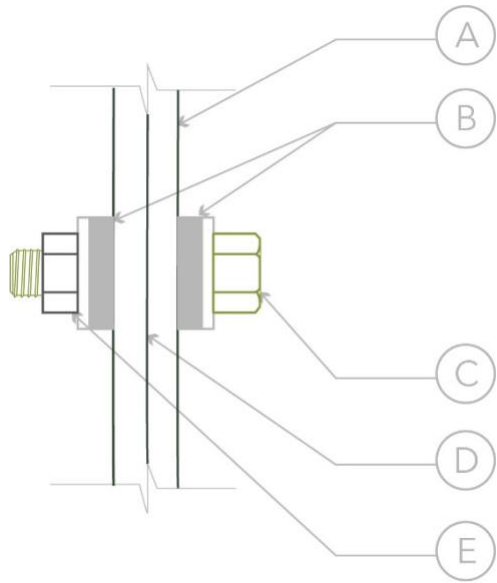


CONNECTION BETWEEN MODULES.

If holes are cut to allow for electrical boxes to be inserted into the openings, make sure to sand the perimeter of the opening with water sandpaper #80 to ensure correct sealing and waterproofing of the joints.

Joint dimension should allow for 1/4 inch minimum and 1/2-inch maximum thickness for sealant. Proper design is 2:1 width to depth ratio. The adhesive must be applied doing a straight cord in the external side next to the holes and then apply it around each hole in a circle, just as shown below. Once a piece is positioned against each other, they will be firmly adjusted to achieve the optimum conjunction of the union. If the adhesive comes out of the joint, remove the surplus with a cloth or a spatula.





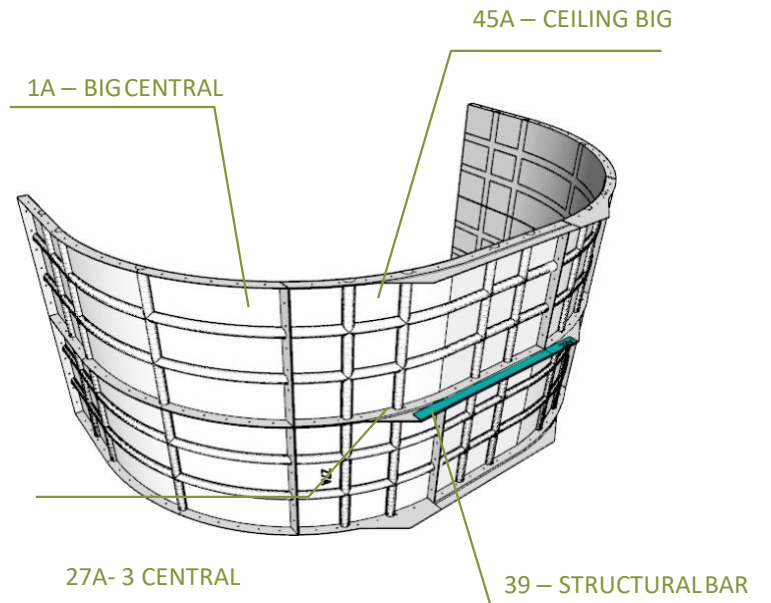
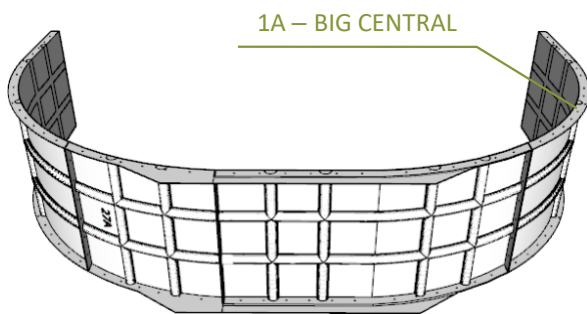
CONNECTION BETWEEN MODULES

- A. FRP Panel flange
- B. Galvanized Steel Washer
- C. 3/8" Dia. Galvanized Steel bolts at 10' O.C. Maxi (Actual spacing varies).
- D. Apply sealant to flange per [W.S. Eco-Homes](#) building and installation manual prior to joining panels.
- E. Nut

The [W.S. Eco-Homes](#) components have tabs and contact holes of 3/8 inch spaced every 20 to 25 cm (7 4/5 to 9 4/5 inches) on average, for the use of 3/8 inch x 1 1/2 inches galvanized steel bolts with nuts and washers on both sides for adjustment and connection.

Galvanized Steel Washers improve the impermeability of the joint between the flanges of the panel, that is way each galvanized-steel bolt should be accompanied by 2 galvanized washers, one at each side, for improving the impermeability in the contact holes.





STEP No. 4

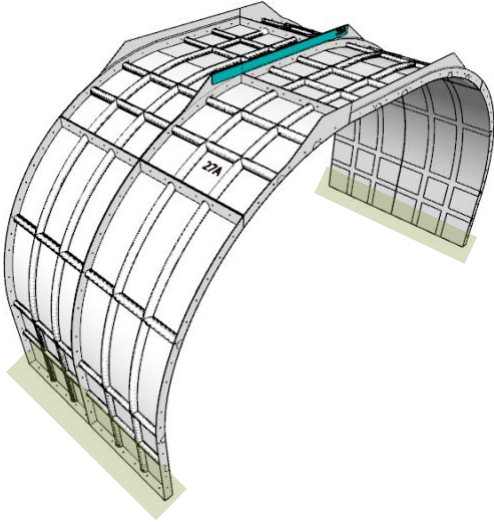
Align component 1A (Big central) next to the 45A. Glue and screw them as shown in the image. In this point you have completed your first arch. Wait 30 min, so the polyurethane adhesive can be cured properly, then you can raise the arch over the slab with the help of the overhead drywall lift.

STEP No. 5

Repeat steps 2, 3 and 4, over the arch you have assembled in the floor, but on step 2 instead of using the 27A component, use the 45A, and on the step 3 instead of using the 45A, use the 27A. Then, pull the double arch up. Use the Drywall overhead or scissors lift if you need additional assistance to pull them up.

ATTENTION:

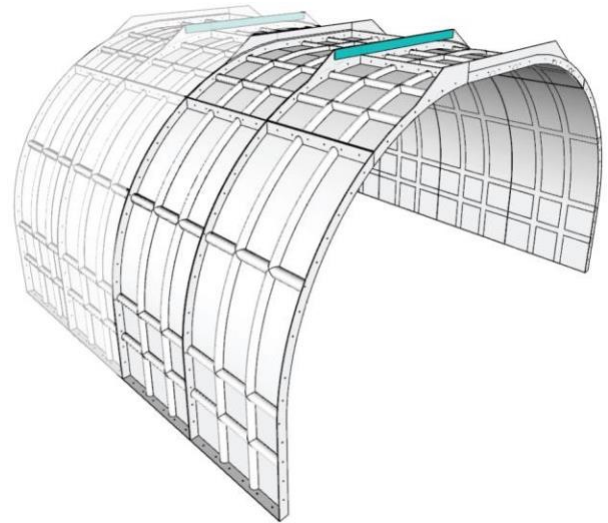
The measurements must be exactly as displayed in the image, so that everything works correctly. You can use the measuring tape or the laser level to make sure you are assembling W.S. Eco-Home with the correct measurement.



STEP No. 6

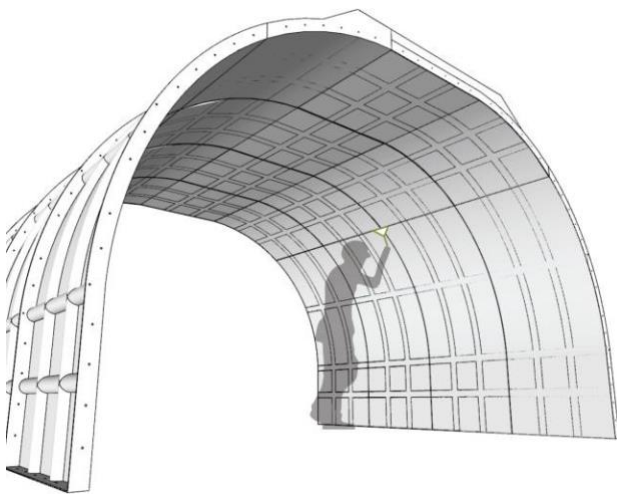
If you have assembled the components as indicated before, the arch should be lifted over the drawing you have made, and it is in the part of the home where it is located following the assembly guide. With a laser level, check to ensure the arch is horizontal and leveled. Now you can proceed to drill the holes for the anchors on the floor.

ATTENTION: insert the mechanical anchors but do not secure them until the next arch is assembled.



STEP No. 7

Assembly another 2 arches on the floor, for this you should repeat steps 2, 3 and 4 next to the one you have lifted on step 5. With this double arch do not secure them in the concrete floor just as you have done with the last double arch in step 5.

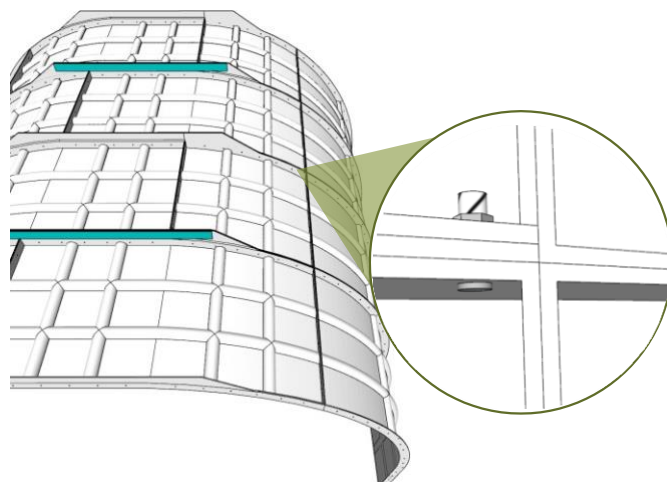
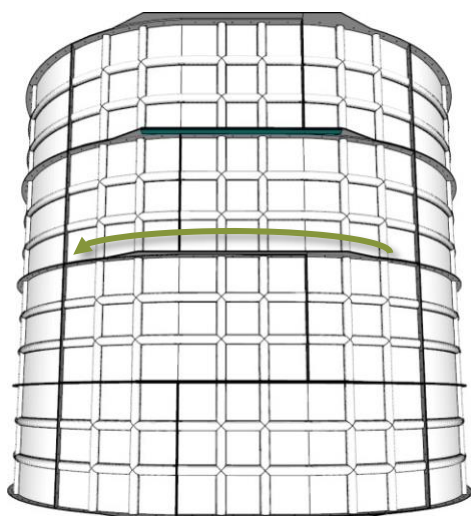


STEP No. 8

Start aligning the double arches between them by the ceiling components. Insert a spatula in the horizontal joint of both double arches, just as shown in the image.

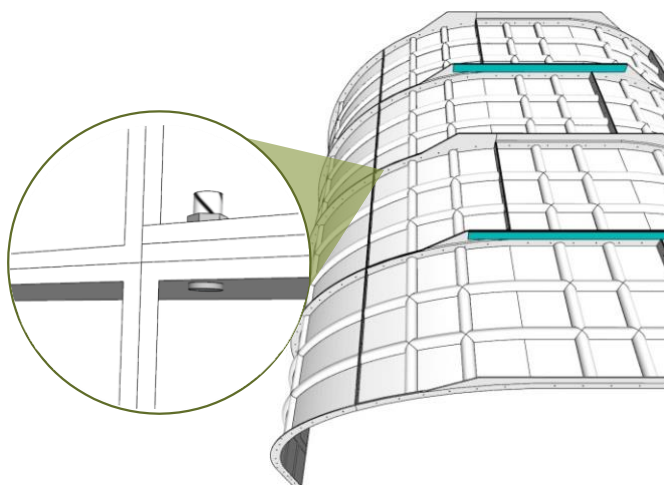
STEP No. 9

The left corner of the ceiling components is aligned with an additional screw by both double arches that have been assembled. A hole is made in the ceiling corner for inserting screws. The roof is started to be screwed by using the overhead drywall lift to align the components during the process.



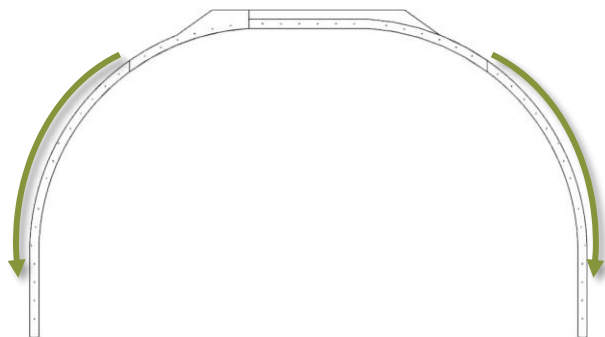
STEP No. 10

The ceiling is started to be screwed using the holes already done in the flaps from left to right just as shown with arrows in image at the right.



STEP No. 11

Then, both double arches are aligned again by the right corner with another screw just as was done in the STEP No. 9.

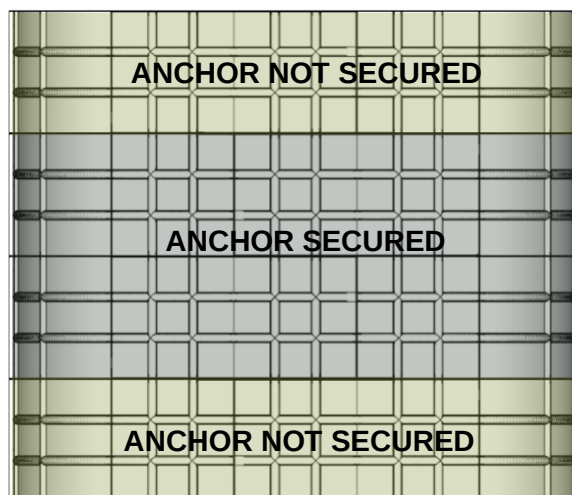
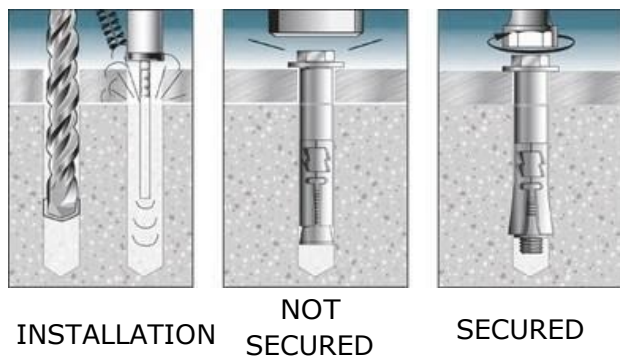


STEP No. 12

Finally, screw the lateral walls by the flanges from the top to the bottom of this joint. You can start either on the right or the left side; it is up to you.

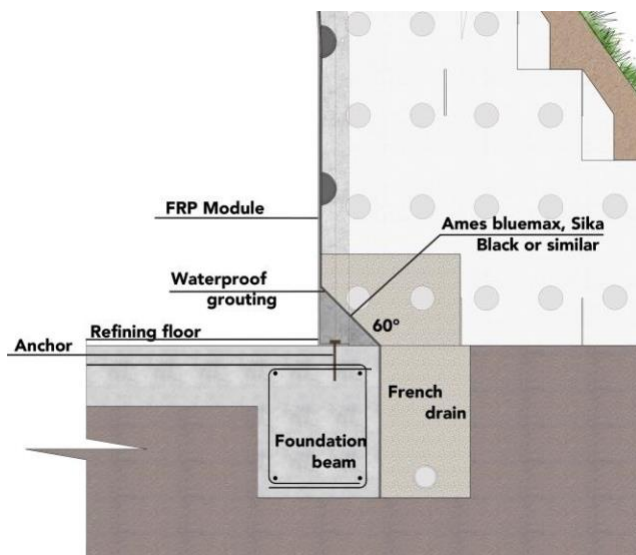
STEP No. 13

To ensure lasting stability, all anchors for both double arches need to be installed. However, make sure that only the single internal arch's anchors are secured - NOT those at either end.



STEP No. 14

Repeat from STEP No. 2 following the directions given by the ASSEMBLY GUIDE for your project. Take this section of the construction manual as a general procedure of the know-how to assemble the technology. However, the correct order of building the home is established in the Assembly Guide.



ATTENTION:

Once the anchors secure the modules to the foundation, these must be sealed to prevent corrosion of the bolts and leakage of water into the unit. To do this, a waterproof concrete slope must be created with a downward angle of 45 degrees over the anchor bolts. Once cured, the slope can be covered with an asphalt mat or elastomeric waterproofing to ensure that the water remains out of the unit.

14. DISCLAIMER

Our products are made with utmost attention to detail and craftsmanship but be aware they may present slight variations in finish due to temperature shifts during the manufacturing process or while being shipped. Though our materials have been tested now for consistency, it's important still consider changes that could occur when exposed to different conditions.

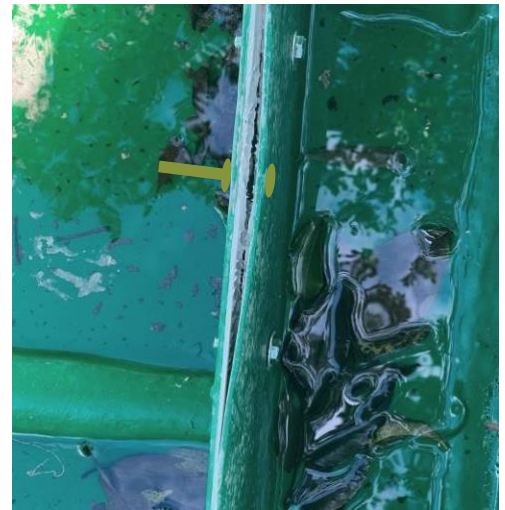
Despite any potential irregularities, **Wonderful Structures** assures that there will be no negative effect on our structures' engineering functionality—maintaining the same quality and value as promised.

To ensure our technology retains its aesthetic appeal, you must correctly address any irregularities arising from the discussed factors. Our expert approach will let you know how to tackle these issues and guarantee a polished end-resend result by applying the following recommendations:

01. A slight space between the fins when they are fully screwed:

Variations in thermal conditions during transit may create protuberances when materials arrive at their destination. To rectify this issue, a screw can be inserted into the center of the raised area and firmly secured - providing an effective solution to complete your project.

Finally, we recommend applying a cord of Sikaflex over the external joints of all the fins and spread it over all the top surface of the joints securing there is not pass of water through the joints.



02. Height differences in the fins or fin sections to be cut

Our product is lovingly crafted by hand, and while we strive for perfection, our human imperfections can sometimes lead to minute discrepancies. If this happens, not to worry - a simple sawing of the affected fin will restore it without compromising the integrity of your components.



03. Alignment difference in gaps for the screws.

Despite our commitment to refinement and attention-to-detail, even the tiniest of human errors can lead to misaligned screw holes. However, this does not impede upon either the strength or performance of our product; instead, a simple drill adjustment nearby will rectify any discrepancies without compromising overall integrity.

04. Embedding in upperchannels

With the ever-changing weather, you may encounter some rain throughout Chapter 18 of FILLING JOINTS BETWEEN 1ST AND ROOF LEVEL. This is not cause for alarm neither a failure of the system as collecting water in these channels can occur – simply drain away any collected liquid and ensure a completely dry surface before moving forward with your task.



15. ELECTRICAL INSTALLATIONS

The electric ductwork must be made externally using PVC flex-pipe, making sure to perfectly seal the perforations with high quality epoxies.

There are many options for connection systems in the market that will ensure complete sealing in case you need to pierce the walls of the technology to place electrical connection points with non-metallic flexible conduit. (LFNC).



ELECTRICAL BOXES

NON-METALIC FLEXIBLE
CONDUIT



The electric boxes should be placed between the nerves of the modules and the flaps. For its proper installation, please follow the next step:

01. Draw over the panel the internal dimension of the electric boxes' module.
02. With the help of the DeWalt 20V Cordless oscillating multitool, cut the square you have already drawn.
03. Put double-sided tape on the internal side of the flaps in the 4 corners of the electric boxes.
04. Apply constructive adhesive, Sikaflex or similar, on the inner side of the flaps of the electrical box.
05. Install the electric box covering the hole you have made in the first steps. Press it firmly, so it is well pasted over the component.
06. To waterproof the module, apply around the perimeter of the box a cord of Sikaflex or similar construction adhesive. Spread it around the perimeter with your finger.
07. Wait until the next day to continue with the waterproofing of these modules.
08. The next day, put tape on the joint between the box and the component.
09. Paint with Blue Max or a similar sealant coating at the perimeter of the electric box.

ATTENTION:

The procedures described from this chapter onwards contain the usage of elastomeric or bituminous sealants, you must use the same type of sealant in each procedure to be consistent with the products used for the waterproofing of the system.

Please, use the electrical boxes to cover the Sprinklers body or any other fixture that is needed to be installed in the component walls.



16. HEAVY WEIGHT HANGING ELEMENTS

Give your heavy items a home! Strategically place large objects such as plasma TVs, air conditioners, cabinets and lamps using fasteners or anchors near the structural veins of technology for extra strength. Remember to waterproof any perforations you make with a drill - read our instructions in upcoming chapters to ensure safe installation.



SEALING TAPE



Bituminous tape



Seam tape or one fabric faced waterproofing tape



SEALING COATING

17. SEALING OF JOINTS WITH SEALING TAPE

Once the structure is completely assembled, glued, bolted, and secured to the foundation slab, follow the next instructions:

01. Clean the surface of the flanges with a brush.
02. One cord of Sikaflex or similar constructive adhesive should be applied in between the external joint of the flap.
03. The next day, proceed to seal or cover all the modules' joints in its external side with seam tape. You can use either Ames Peel & Stick™ Seam Tape (4"inch x 50'), the bitumen Sika Multiseal Tape (Sika Black Tape) 10cm (4" inch) wide or any other similar tape.
04. Apply sealing coatings, such as Tritonflex 1K, Sika Black seal coating, Ames Bluemax, or similar, over the tap, and cover the joint between the tape and the component.
05. Wait 2 hours minimum and apply another layer of sealing coating.

18. WATERPROOFING OF PERFORATIONS

01. Cover all the screws near the perforation with Sikaflex or a similar construction adhesive on the external and internal side.
02. Proceed to paint all screws with a sealing coating, such as Tritonflex 1K, Sika Black Seal coating, Ames BlueMax®. or similar on the outer surface
03. Wait 2 hours minimum and apply another coat.

19. FILLING JOINTS BETWEEN 1ST AND ROOF LEVEL

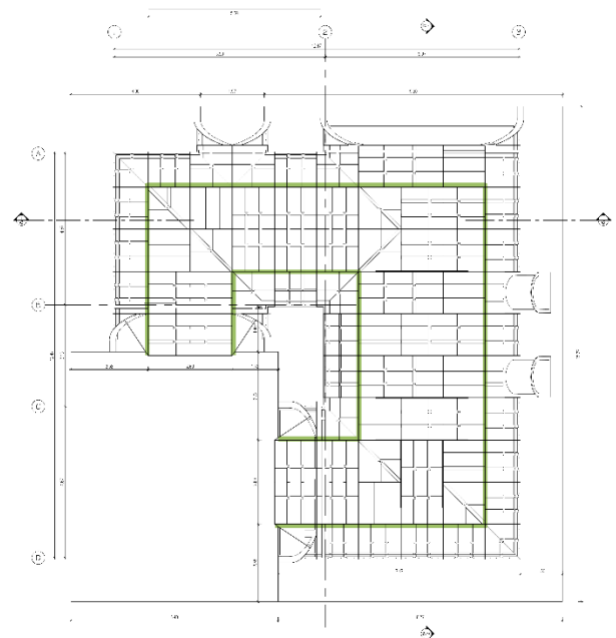
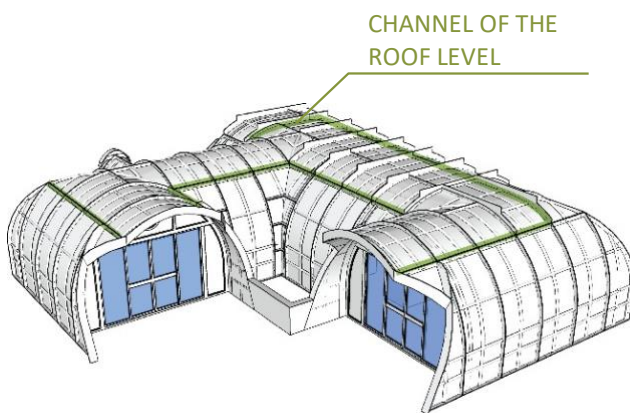
ATTENTION: This step can be skipped when the layer of polyurethane foam is going to be applied in the ceiling,

Once the structure is fully assembled, waterproofed and the joints are sealed, proceed with the next steps:

01. Fill the channel of roof level with a mixture of cement, as shown in the photos. For this purpose, the recommended mixing proportion is specified in the relation *OPC (Ordinary Portland Cement): FA (Fine aggregate): CA (Coarse aggregate)*, which has a numeric value of 1: 2.52: 3.4, considering that for this mixture the water to cement ratio is of 0.59, with these specifications the mixture of cement will have a strength of 21 MPa.
02. Paint with sealing coating the upper channel once the concrete is set, just as shown in the photo at the right.



CONCRETE CHANNEL PAINTED
WITH SEALING COATING



20. INTERNAL JOINT SEALING

MATERIALS NEEDED

- Filler paste.
- Catalyst dispenser
- Wood or plastic base with a stirring stick * Not included in the order.
- Sandpaper #36 - #180

WARNINGS AND OBSERVATIONS

- The preparation will dry to touch in 8 minutes and is sandable at 20min.
- The preparation will decrease its thickness once is dry.
- The client can use a fiber-glass mesh or tape, on the inferior part of the components before the appliance of the mixture, so the components obtain more resistance to natural changes in the environment.

MIX PREPARATION

Once the project is entirely put together with the Sikaflex dried between the joints of the component, it is important to reinforce the waterproofing of the structure. The process of sealing the internal joint of the modules differs from the components of the walls to the components of the roof. Please follow the next instructions consequently:

Roof components internal joint sealing:

01. Clean the internal joint using the spatula included in the repairing kit.
02. Apply a cord of Sikaflex in between this joint in the internal side and spread it with the fingers all over these upper joints.

Wall components internal joint sealing:

01. Clean the internal joint surface.
02. Put the fiberglass adhesive tape in the joints of component 1A, which has a hollow in these joints for its internal sealing, as shown in the image at the left.
03. On a plastic or wood surface mix at least 150 or 200 gr of the paste WHITE GELCOAT PUTTY POLYESTER RESIN ® FGCI™ (www.fgci.com) or similar, with the catalyst dispenser at 5%, and blend until the substance is entirely homogeneous.
ATTENTION: Please use the catalyst of the product so that it can solidify correctly.
04. Use the paste made in the previous step to apply it between the component seams. The first coat must not go all the way to the top of the components. Let dry for 20 min.
05. Once the first coat is dry, sand with coarse-grit sandpaper (#36).



FIBERGLASS MESH
ADHESIVE TAPE OR TAPE





EPOXY PASTE

06. Clean the surface and apply a second coat, this must go all the way to the top of the components, the third coat is optional.
07. After all the coatings with the mix are dried, polish the rest of the dried mixture with fine grit (#180) sandpaper, so that it can be placed at the level of the other components.
For final finishing details, conventional materials can be used to patch and smooth the surface before painting.
08. Once all the components are fixed and smooth on the interiors, the panels can be painted or finished as desired.
Now all the internal surface is ready for painting.



21. INSTALLATION OF WINDOWS AND DOORS

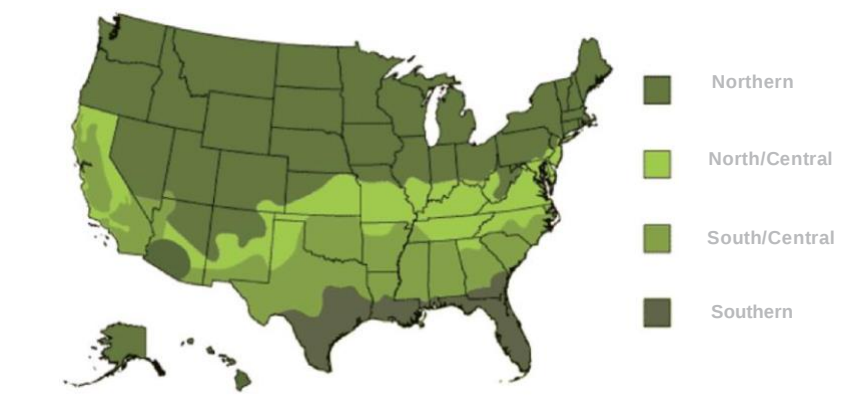
ATTENTION:

Wonderful Structures DOES NOT manufacture any window or door the client requires for its project, so these items are not included in our orders or quotes unless written specification. We always recommend the client look for a local window and door supplier, considering the R-Value required locally. This chapter aims to explain to the client the general facts of the thermal requirement needed for the doors and windows according to the USA zone, but the client should confirm this information with their window and door supplier.

In the USA, the Energy Star Program has been applied to windows and covers residential windows, doors and skylights within one Ecolabel. Qualification for this scheme is based on the U-value and G-value (SHGC) of each component taken together and incorporating their relative values. The scheme also considers the differing requirements of the various regions of the USA, with the required U and G-values (SHGC) altering accordingly. The table below shows the range of these values that is accepted according to the area in the USA and its equivalent U-value in Europe:

Climate Zone	U-Value *	Equivalent European U-Value ***	G-Value **
Northern	≤ 0.35	1.99	Any
North/Central	≤ 0.40	2.27	≤ 0.55
South/Central	≤ 0.40	2.27	≤ 0.40
Southern	≤ 0.65	3.69	≤ 0.40

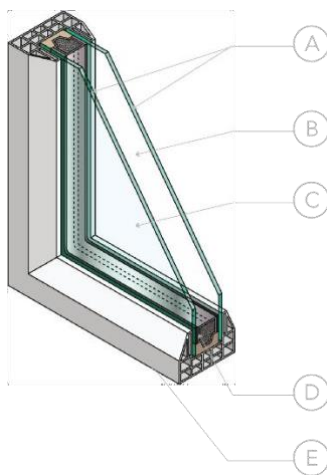
* U-value: The rate of non-solar heat loss or gain through a material or assembly. Expressed here in units of Btu/h·ft² ** G-value / Solar Heat Gain Coefficient (SHGC): The fraction of solar radiation admitted through a window, door, or skylight. Expressed as a value between 0 and 1. *** Multiply American U-value by 5.68 to give European U-value in W/m²·°K



Many ENERGY STAR certified doors and windows have some or all the product features detailed below.

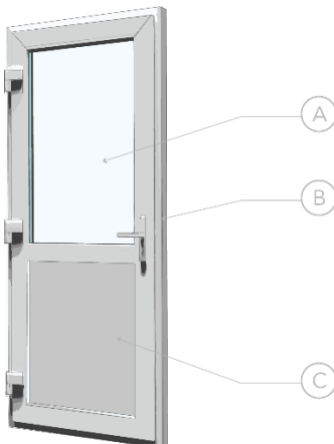
For more information go to https://www.energystar.gov/products/building_products/residential_windows_doors_and_skylights/key_product_criteria

Windows, doors and skylights protect you from the elements just like a winter coat. But like a winter coat, you should pick the windows, doors and skylights that make the most sense for your climate. While some windows, doors and skylights are better at keeping you warm, others excel at keeping you cool. For example, homes in Florida, in the southern region, need windows that have a cooling effect on the house, whereas homes in Washington State, in the northern region, require windows that retain heat.



WHAT MAKES A WINDOW ENERGY-EFFICIENT?

- A. Multiple Panes**
Two panes of glass, with air/or/gar/filled space in the middle, insulate much better than a single pane of glass. Some ENERGY STAR qualified windows include three or more panes for even greater energy-efficiency, increased impact resistance, and sound insulation.
- B. Gas Fills**
Some energy-efficient windows have argon, krypton, or other gases between the panes. These outdoors, colorless, non-toxic gases insulate better than regular air.
- C. Low-E Glass**
Special coatings reflect infrared light, keeping heat inside in winter and outside in summer. They also reflect damaging ultraviolet light, which helps protect interior furnishings from fading.
- D. Warm Edge Spacers**
A spacer keeps a window's glass panes the correct distance apart. Non-metallic and metal/non-metal hybrid spacers also insulate pane edges, reducing heat transfer through the windows.
- E. Quality Frame Materials**
A variety of durable, low-maintenance framing materials reduce heat transfer and help insulate better.



WHAT MAKES A DOOR ENERGY-EFFICIENT?

- A. Multiple Panes**
Double or triple-paned insulating glass is used to reduce heat flow.
- B. Tighter Fit and Improved Weather Stripping**
New frames may include a magnetic strip to create a tighter seal that reduces air leakage around the edges.
- C. Improved Core Materials**
Fiberglass, wood cladding and steel with polyurethane foam core are among the most energy-efficient door materials available today.

W.S. Recommended Doors and Windows – Three Types of Glass Panes:

01. Single pane crystal clear glass on euro-spec pvc frame
02. Double pane laminated crystal clear glass tempered with pvb on euro-spec pvc frame
03. Double pane laminated crystal clear camera glass tempered and filled with argon gas on euro-spec PVC frame.

22. WATERPROOF VERIFICATION USING THERMAL IMAGING CAMERAS

Water leaks and moisture infiltration can be presented anywhere around the home and can be difficult to detect until it is already too late. Finding any leaks early will not only afford you a comfortable and energy efficient home but also reduce the overall energy loss and expensive repair bills.

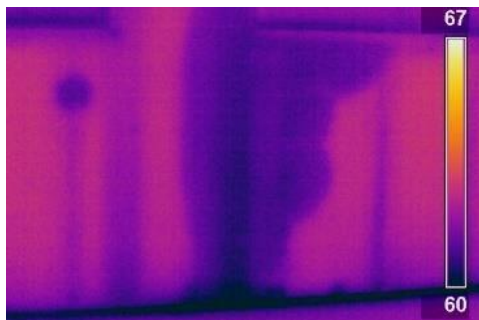
Thermal imaging devices that see over the infrared spectrum give us a view of the temperature differences based on the light energy we cannot see. Homeowners can now get a visual confirmation of energy variations, allowing easy detection and the ability to identify hard to see problems and safety hazards, which ultimately saves time and money. Thermal leak detectors will help you in spotting the hot/cold spots in your property or home so you can take action to resolve the matter quickly.

According to the NTE QAN/1973, which regulates the non-passable roof waterproofing, proceed to run an waterproofing test by splashing the structure

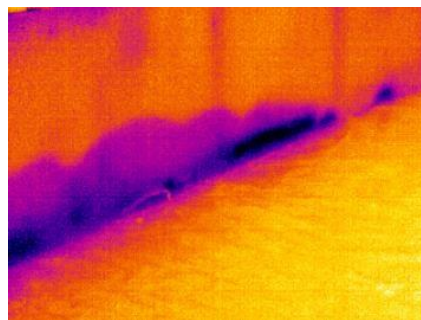
with plenty of water to ensure that there are no water filtrations, then use a thermal imaging camera to detect any leakage.

These cameras can see the plumbing areas, pipes or behind the wall that are causing the moisture to get inside the house before the problem get bigger. In addition, they are useful in detecting electrical shorts, poor HVAC performance, air leaks, missing insulation, and other costly inefficiencies.

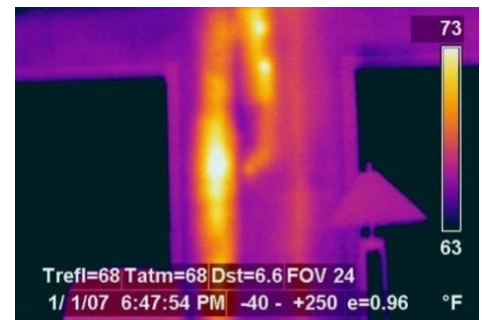
Moisture in buildings usually spreads in a recognizable pattern depending on where the water is, some examples are showed below:



Walls: Top - down triangular shape formed as water spreads downwards.



Flooding: water wicking up a wall into the insulation and up wall studs.



Hot Water Pipe: leaks shows as a warm area

There are many options for thermal imaging cameras in the market that are very useful, some examples are listed below:

- FLIRC2 Thermal Camera with MR40

Moisture Pen

- FLIRTG165 Thermal Camera and Moisture Pen
- Seek Thermal Reveal Thermal Camera

23. INTERIOR WALLS CONSTRUCTION

The construction plans will dictate the placement of the interior walls to create internal spaces: configure bedrooms, bathrooms, among other spaces. Once you have identified the location for placement of these internal walls, you have 3 options for making them:

01. Drywall with metal profiles. The metal profile can be adapted to the curve by using one of the following methods:
 - The metal profile can be sectioned for it to give the curve needed internally, just as shown in the image at the right.
 - A U-profile can be adapted to the curve and over the floor, so the internal profiles of the wall can be attached in the top and bottom profiles.
02. Drywall with wooden profile
 - The wood profile is supported on the component and screwed over it without a profile over the curve.
03. Masonry or concrete blocks
 - The blocks need to be cut to adapt to the curve.



04. Hybrid internal wall system

- A U-profile can be adapted to the curve and over the floor, so the internal profiles of the wall made of wood can be attached in the top and bottom metal profiles, just as shown in the photos at the right.



24. THERMAL INSULATION REQUIREMENTS FOR BUILDINGS

The thermal insulation needed in a building depends on a variety of factors, including the climate in which the building is located, the type of heating and cooling systems being used, the type of construction and materials used in the building, and the intended use of the space.

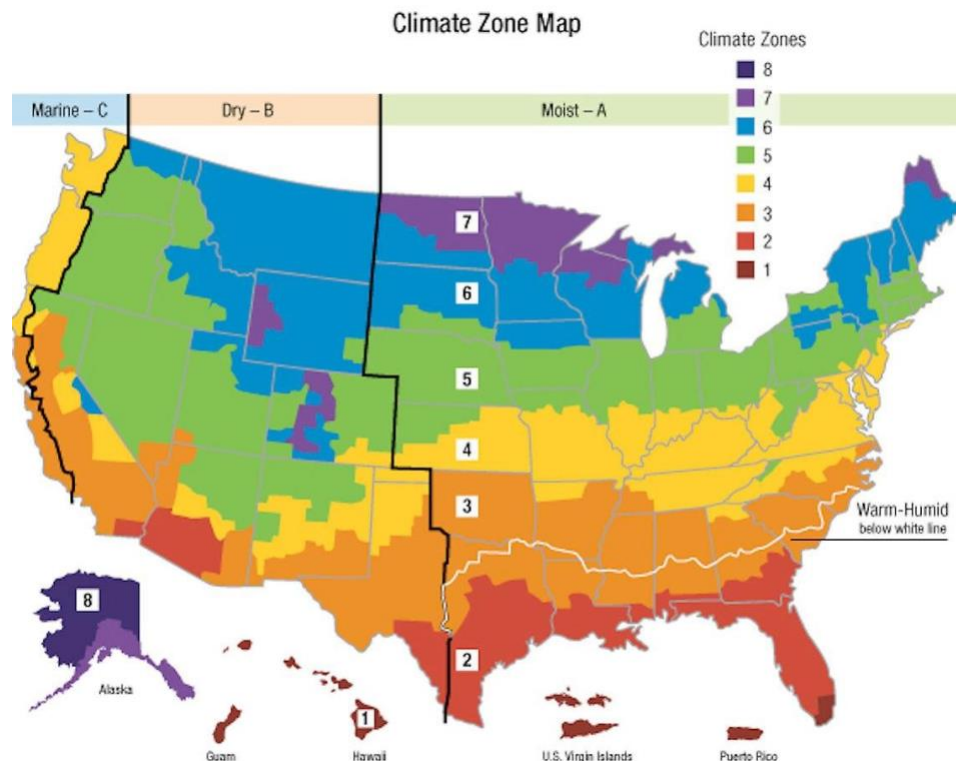
In general, buildings in colder climates will require more insulation than buildings in warmer climates. The insulation requirements for buildings in the United States are established by the U.S. Department of Energy (DOE). These requirements are based on the climate zone in which the building is located and are intended to ensure that buildings are adequately insulated to minimize heat loss and maximize energy efficiency. These requirements are based on the R-value of the insulation, which is a measure of its resistance to heat flow. The higher the R-value, the more effective the insulation is at preventing heat loss.

The minimum insulation requirements for each climate zone are as follows:

Minimum insulation R-Value required.

Zone	Attic	Walls	Floors
1	R-49	R-13	R-25
2	R-38	R-13	R-25
3	R-30	R-13	R-25
4	R-30	R-13	R-25
5	R-30	R-13	R-25
6	R-30	R-13	R-25
7	R-30	R-13	R-25
8	R-30	R-13	R-25

In addition to these minimum requirements, it is generally recommended that buildings in the United States be insulated to the maximum levels recommended by the Department of Energy. This can help reduce energy consumption, lower energy bills, and improve the overall comfort of the building.



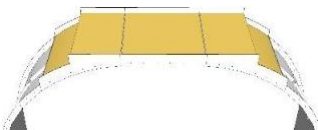
25. APPLICATION OF POLYURETHANE FOAM RECOMMENDED

Once the structure is fully assembled, sealed, with doors and windows installed, proceed with the application of the Thermal insulation layer using polyurethane foam. The thickness of the polyurethane foam layer will vary depending on the insulation requirements on site, explained for the United States in the chapter before.

For tropical climates you will only need to apply 10 cm (4 inches) of polyurethane foam in the upper deck modules, since the lower structural walls have a thick layer of soil that will give them sufficient thermal insulation.

For extreme climates with temperatures below freezing or extremely hot, apply polyurethane foam across the structure in a thickness equivalent to 2.5 cm (1 inches) per each 6 R factor - See: <http://www.spf.basf.com/faq.php>.

One of the products recommended is of Huntsman, you can find it in the next link: <https://huntsmanbuildingsolutions.com/en-US/products/closed-cell-insulation>



26. COVERING THE STRUCTURE WITH HDPE PLASTIC MEMBRANE

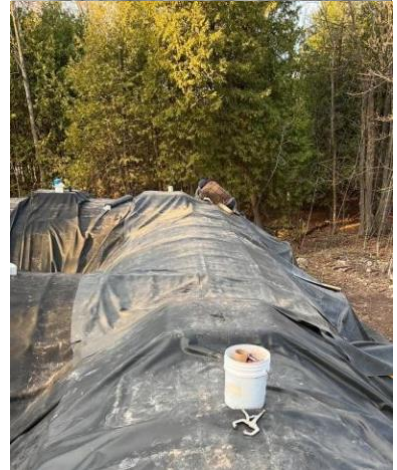
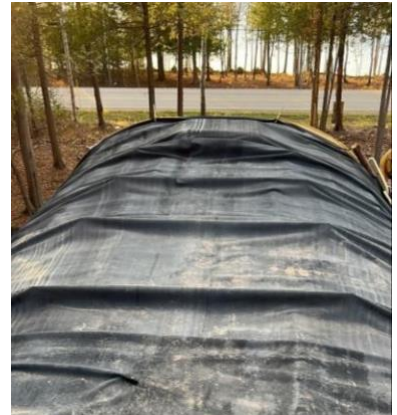
Now that you have assembled and waterproofed your home, proceed to cover the entire structure with high density polyethylene geomembrane (HDPE)

Covering all the structure, with high density polyethylene (HDPE) will help reinforce the waterproofing of your **W.S. Eco-Home** and will help protect from roots.

Please, be aware of the next steps during this procedure:

01. Measure your home over your roof from corner to corner.
02. Calculate how many sheets do you need to cover the length, please be aware that the sheet should cover all the roof and one step of the **R.W System**. Also, the overlap between the sheets should be of a minimum of 10 cm.
03. Extend these HDPE sheets over the floor.
04. Overlap the sheets 10 cm between them.
05. Paste the sheets using seam tape.
06. Extend the sheets pasted over the surface and use seam tape to paste it in all the perimeter to the **R.W System**.

ATTENTION: If you use the **R.W System** as your sloped berm wall construction method, extend the HDPE until the 7-step counted from the bottom to the top. If you use another construction method for the sloped berm wall, cover the entire sloped wall until floor.



27. SOIL COVER

SOIL FILLING

a. MECHANICAL FILLING WITH BARK BLOWER

Bark blower is a machine that blows bark, wood chips, or other mulch material into a specific area. These machines are typically used in landscaping and gardening to cover the ground with a layer of mulch, which can help to suppress weeds, retain moisture in the soil, and add a decorative element to the landscape. Bark blowers are often used in commercial and residential landscaping projects, as well as in forestry and other types of land management. Some bark blowers are small and portable, while others are larger and mounted on trucks or trailers. They typically have a large hopper holding the mulch material and a powerful blower system that can blow the material long distances.

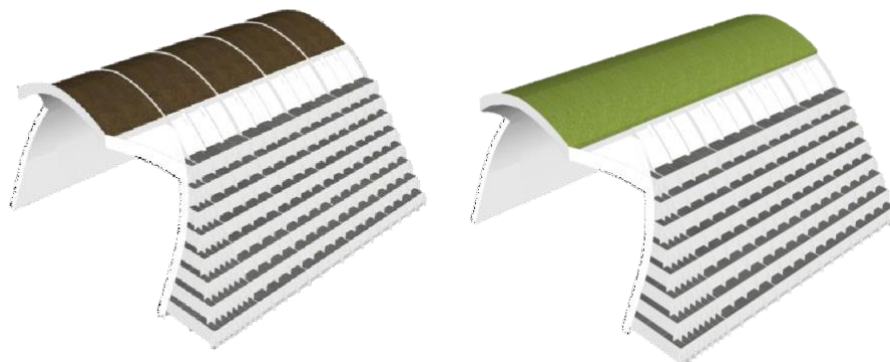
This machine can blow a mixture of soil, bark, and wood chips over the structure. The mixture is more compact than soil without cohesive chips, which helps the soil retain itself over the slope.



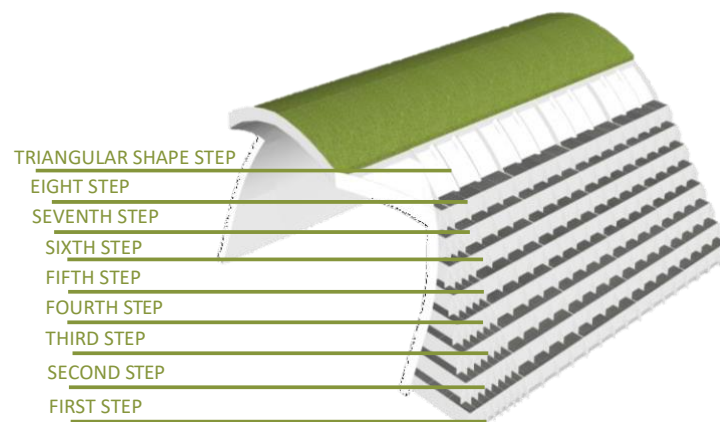
b. BY HAND FILLING STEPS

01. Cover the entire top deck with 10cm (4 inches) of fertile soil.

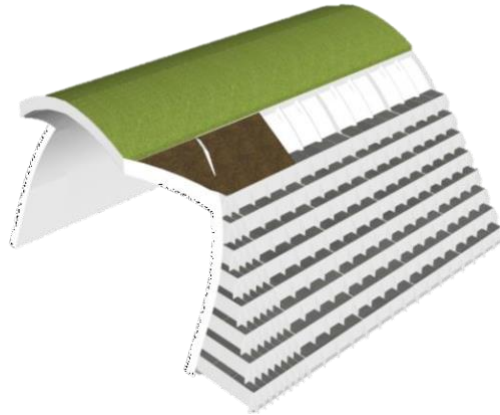
Cover the fertile soil with vegetation squares or the plants you have chosen to cover your project.



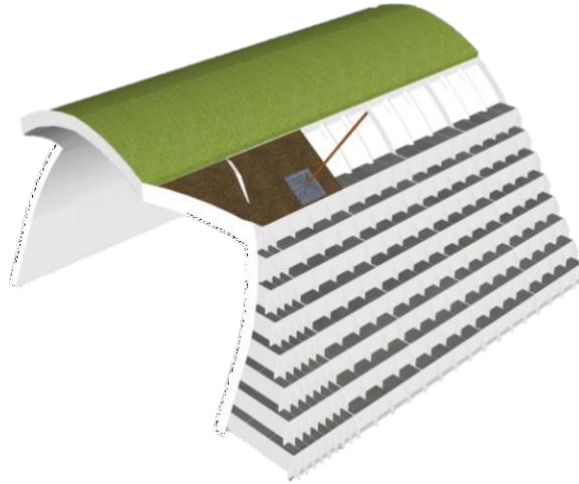
02. Once the cover is completely ready, you should start filling it step by step, going down one by one. Mix a portion of soil with a little water and stir very well until you achieve a densely plastic clay.



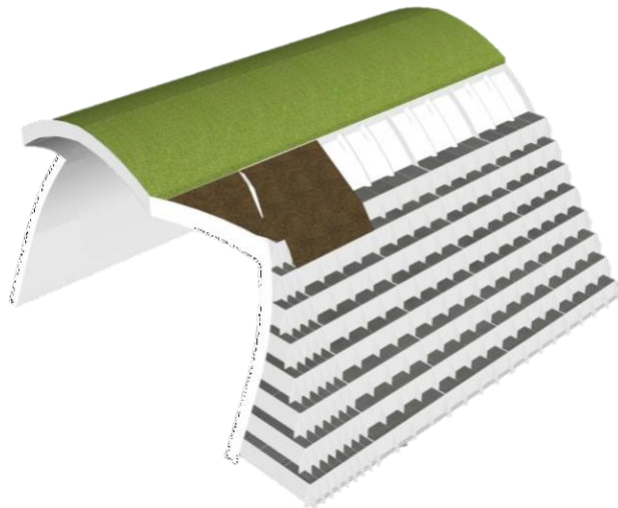
03. Start by filling in the triangular section of the upper level of the **R.W. System**, up to the edge in a section 1.30 meters (4.3 feet) wide. Firmly compact backfill with a tamper.



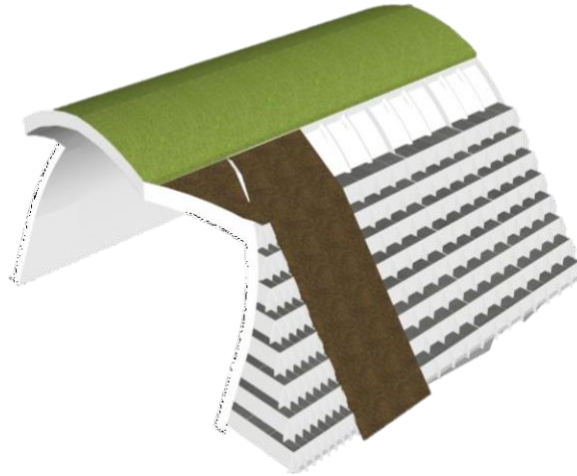
Refill portions of the upper level as required and re-compact until a smooth sloped surface is achieved.



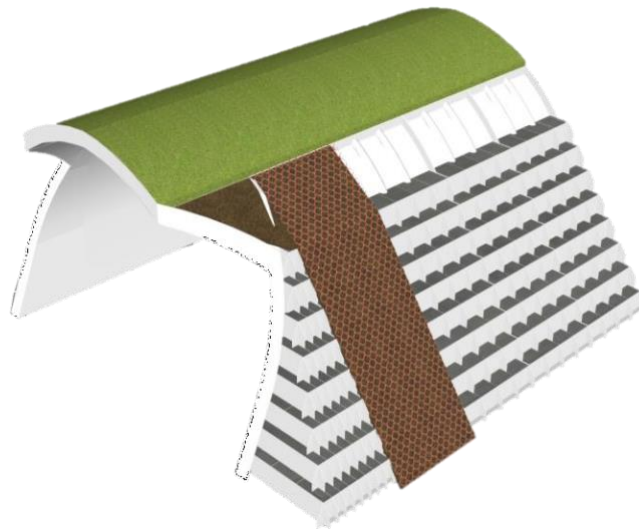
04. Proceed to fill the next lower level, up to the edges of the **R.W System** and repeat the same procedure.



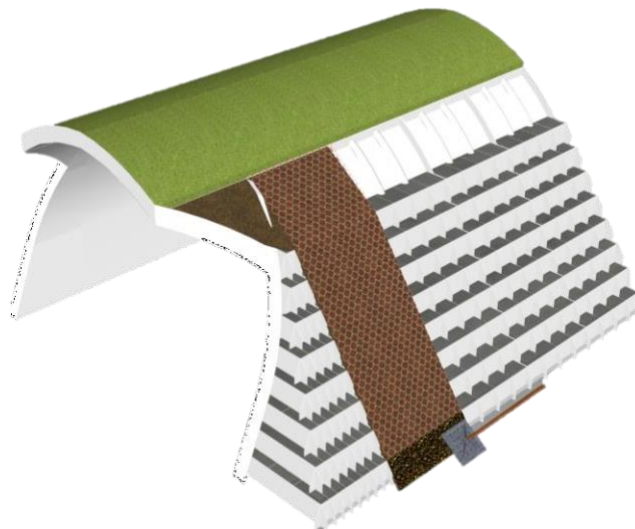
05. Repeat the same procedure with levels 7, 6, 5, 4, 3, 2 and 1.



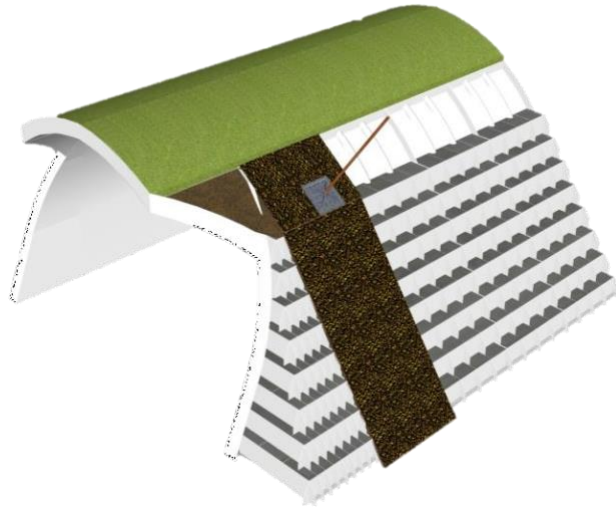
06. Place a plastic mesh on top of the 9 levels, the width of the filling: 1.30 meters (4 ft 3in) wide.



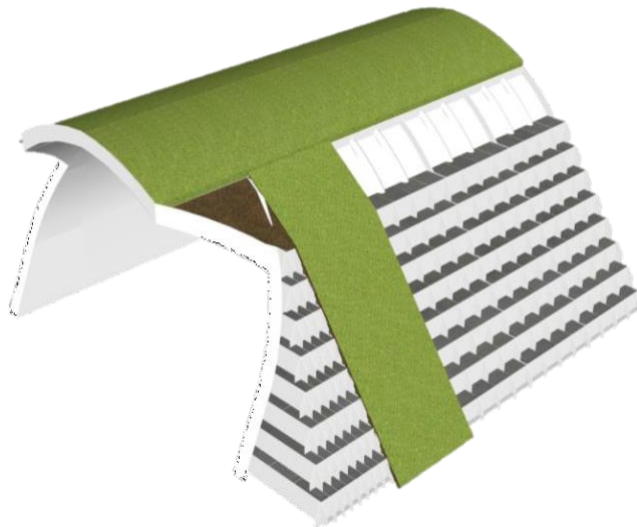
07. Start compacting a layer of soil 6 cm. (2 inches) approx. Covering the plastic mesh, starting from the bottom up. This mesh will serve to tie down the land and the vegetation that will be placed later.



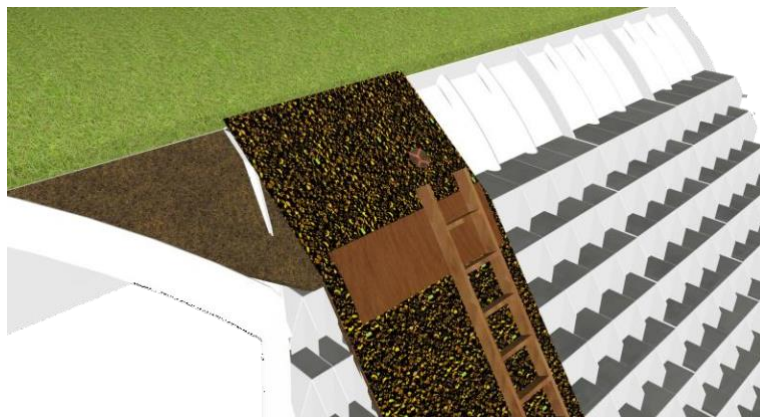
Cover the 8 levels with this layer of compacted soil of 6 cm. (2 inches) approx.



08. OPTION 1 - Once you have covered the entire mesh with soil, cover the soil with vegetation squares or plant it with individual plants.



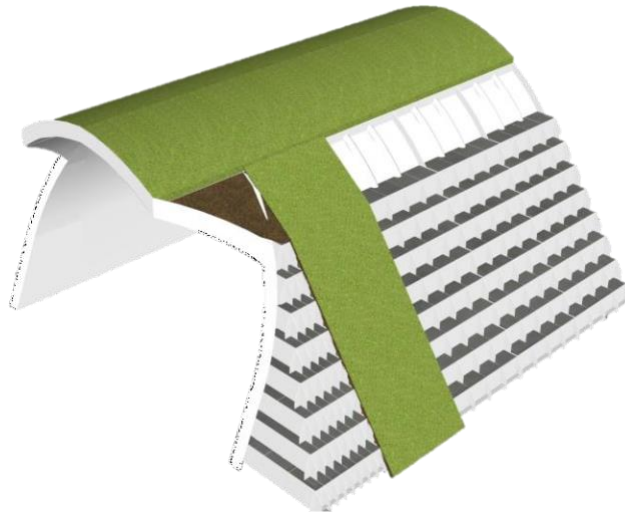
09. OPTION 2 - If the soil is going to be covered by placing individual plants, a ladder must be used to locate them.



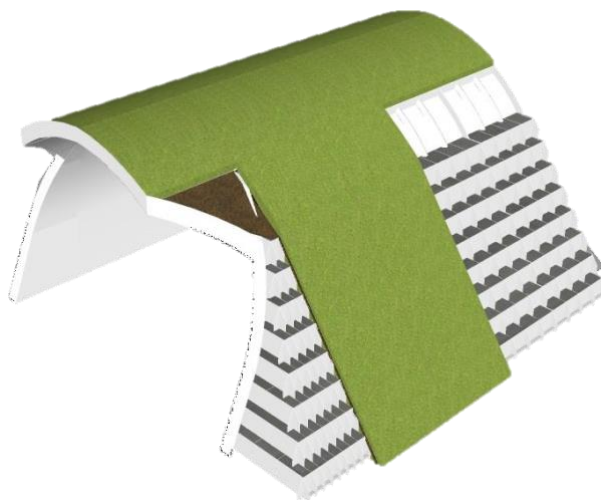
Use a ladder and a wide board to support the ladder on compacted soil, if needed. Vegetation squares or individual plants will serve as tie-downs and prevent the compacted soil from collapsing.



10. It is not recommended to leave the exposed soil without vegetation for a long time as the sun and wind will dry it out and it will fall, causing the work to be lost.



11. Repeat the same procedure described above every 1.30 meters (4ft 3in) wide, until the entire structure is covered.



12. Periodically water the vegetation that covers your project and keep it enriched with nutrients, so that it always looks green and beautiful.

ATTENTION:

Depending in the location of the project, it can be convenient to install an automatic irrigation system. For that it is recommended to contact a technician specializing in garden irrigation.

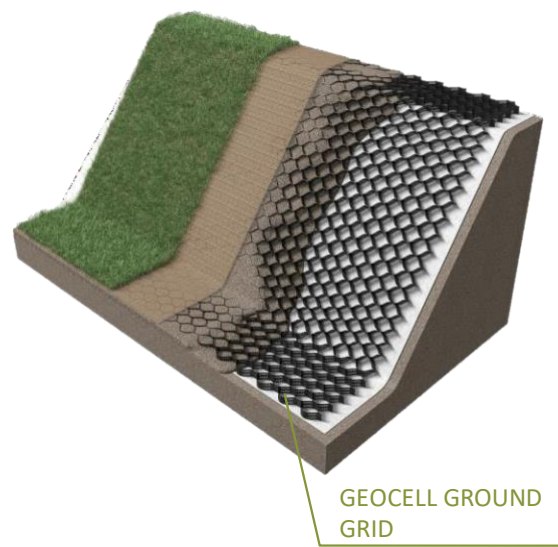
SOIL RETAINING

c. GEOCELL GROUND GRID

If retaining the soil in place over your home has been challenging, here we can give you some recommendations that will help you overcome this issue easily.

A geocell ground grid is a three-dimensional geosynthetic material used in soil stabilization and erosion control. It is made of a flexible, honeycomb-like structure filled with soil or other infill material. The geocell ground grid is typically high-density polyethylene (HDPE) or durable, weather-resistant plastic. It is used to reinforce and strengthen the soil, particularly in areas where the soil is prone to erosion or is not stable enough to support the weight of vehicles or structures.

The material is unrolled and attached to the ground using stakes or other anchors to install a geocell ground grid. The cells are then filled with soil or other infill material, and the grid is compacted to create a stable, reinforced surface. In [W.S. Eco-Homes](#), Geocells are used for slope stabilization of soil during and afterward the construction of the homes.



28. LAWN LAYING AND LANDSCAPING

We recommend using germinated turf or vegetation squares ready to install that are available in the market. To avoid cutting and maintaining topsoil, use self-pollinating plant species that do not require cutting or pruning, like ground cover plants, worldwide. A list of plants is available inside the W.S. Club.

See the example in Courtyard Magic Video:

<https://youtu.be/EgcBLiHDIE>



HIDROGEL WATER CRYSTALS

The hydrogel water crystals help to retain water at the roots of the plants, this has a variety of benefits, and some of them are:

- Improve water availability for plants, by increasing water holding properties of growing media (soils or soilless substrates), which enhance the healthy growth of the grass.
- Water isn't lost to evaporation since it's held back in the crystals.
- Roots will always look for the crystals saturated with water, which means that it helps to control their growth.

For more information about the dosage of hydrogel in the soil, please visit the next page <http://hydrogel.info/hydrogel-instructions.html>

If you decide to include Hydrogels into the soil, please follow these instructions:

01. Mix the hydrogel completely into the soil before covering the structure.
02. Cover the structure with soil as specified before.
03. Plant the grass or the germinated vegetation squares in the soil.
04. After planting, water the grass thoroughly to maximize the Hydrogel's absorption process.



29. GREEN ROOF PLANTS

An extensive green roof is a completely natural form of roof covering that uses a low-maintenance planting scheme consisting of hardy, drought-resistant plants. The plants used should be self-regenerating, predominantly short growing, densely planted, and exhibit a high degree of adaptability to survive in relatively extreme climatic conditions (drought, sun, wind, frost, etc.). Ideally, the plants should originate from the Central European flora, although when choosing the plants, regional variations and local climatic conditions are to be considered.

When choosing the plants, regional variations and local climatic conditions are to be considered. Also, it is better to choose local species, it will secure the life expectancy of the plant. `

The plants selected should require minimal moisture and demand little from the substrate in the way of nutrients. In general, irrigation systems are unnecessary for extensive installations, although irrigation may be required during the early stages to support germination and initial growth.



30. FIRE RESISTANT COATING.

Priming and finishing the interior walls with a fire-resistant coating is the most important step to ensure the reduction and spread in the event of an internal fire.

FIRE RESISTANT COATING:

Our fiber reinforced polymer (FRP) panels have been tested to determine the relative burning behavior according to the ASTM E84 standard of materials by observing the flame spread along a specimen test piece. The FRP fire resistant behavior can be improved by using one of the next two products of intumescent fire-resistant coatings, which create a thin film fire retardant, proving a fire resistant barrier on a wide range of interior building surfaces.



Ff88 is a water-based latex paint and its application is like applying a regular water-based latex paint, the recommended width of the layer for **W.S. systems** is 20 mils dry thickness. Ff88 can be brushed, rolled or sprayed using an airless spray gun. Additionally, because of its high percentage of solids, it will have an excellent spread rate and coverage.

FF88 comes in a white, flat finish. If a different color or finish is desired, FF88 can be top coated with most premium paints to achieve the desired color and finish.



Fireguard ® E-84

FireGuard® E-84 is a non-toxic, water-based formulation that has been approved for use on specific interior surfaces only. While the use of an airless sprayer is strongly recommended, FireGuard® E-84 may also be applied by brush or roller. If a certification of application is needed or required by governmental or regulatory agencies, or other parties, an ICC certified professional (or an outside independent testing agency with comparable certification that has been approved by the regulatory agency) MUST be contracted to verify that FireGuard® E-84 has been applied in a uniform manner with a proper thickness.

To seal the Fireguard coating, it is recommended to use FireGuard Z-1 Tie-Coat, which is a water-based coating designed to be used as an intermediary sealant between FireGuard E-84® Intumescent Coating and an approved topcoat in interior and exterior applications. FireGuard Z-1 Tie-Coat is specifically designed to seal in FireGuard E-84® Intumescent Coating when the option of a top coating the intumescent material is desired to match the interior aesthetics of the structure or warranted exterior applications.

For making a fire-resistant coating, apply a layer of 15 mils dry thickness of Fireguard ® E-84 and then, apply an approx. 3 to 5 mils thick layer of Fireguard Z1.

Please consult the applications instruction of the fire-resistant coating for application and product information details to be considered.

31. PAINTING INTERIOR WALLS

ATTENTION: IMPORTANT NOTE BEFORE PAINTING THE INTERIOR Make sure the exterior roof surface is coated with soil and the garden and plants are installed, then allow the soil time to settle to completely stabilize the structure **BEFORE** doing any interior painting or finishing. Once settled you may proceed to heal joints and paint as desired.

The inner walls of the technology can be painted any color you choose.

We recommend using acrylic paint, which has very good compatibility with polymer surfaces.

It is advisable to apply a first coat of primer and then apply the paint. This will give the best adherence and long-life expectancy.



32. LIGHT AND MEDIUM WEIGHT HANGING ELEMENTS



Light and medium weight hanging elements such as: Decorative paintings, mirrors, light fixtures, medium size TVs, decorative objects, sconces, and all elements that have a weight equal or less than 11.34 kg (25 lb), it is enough to use high adhesion tape such as 3M Dual Lock Fasteners or Command® strips and paste it over the wall.

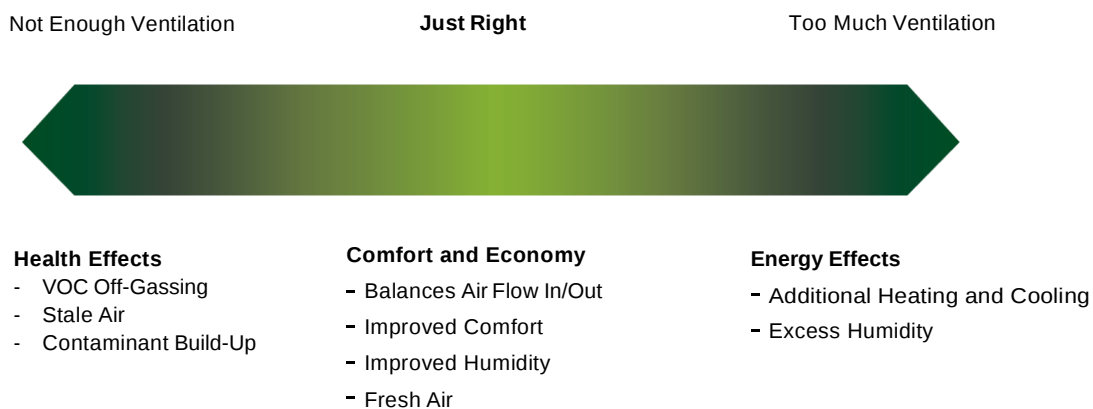
APPENDIX A - VENTILATION & ENERGY EFFICIENCY OPTIMIZATION

Why is Ventilation Important?

According to U.S. Environmental Protection Agency studies, on average, people spend approximately 90 percent of their time indoors where pollution level concentrations can be up to five times higher than typical outdoor levels due to a myriad of issues. Proper ventilation can reduce airborne indoor pollutants such as dust, mold, gasses and chemicals. Proper sizing is vital for maximizing the benefits of fresh air ventilation. Not enough or more than enough ventilation can cause problems, including poor indoor air quality, comfort issues and wasted energy.

How Ventilation Affects Efficiency

Opening windows will provide some fresh air but will result in much higher heating and cooling costs. A properly designed ventilation system offers a more sensible approach than just opening the windows, which is not practical in the heat of summer or the freezing environment of the winter. It provides the required ventilation and maintains a higher energy efficiency by recovering heat or energy from the outgoing air and transferring it to fresh, incoming air. This allows the incoming air to match the temperature of air circulating through the home. As a result, there is minimal heat loss in the winter, humidity stays under control during the summer and the homeowner can enjoy energy-efficient comfort all year long, maximizing energy efficiency while lowering utility costs.



Ventilation and IECC

For builders, there is the matter of meeting IECC (International Energy Conservation Code) standards regarding airsealing. In order to comply with the 2012 IECC standards, a home must pass both visual inspections as well as meet the air changes per hour (ACH) threshold of less than five per hour in climate zones 1 and 2, or less than three per hour in climate zones 3 –8.*

Ventilation Systems

There are several options for mechanical ventilation systems. Spot ventilation, using exhaust-only fans in the kitchen and bathroom, removes water vapor and pollutants from specific locations in the home, but does not distribute fresh air. Balanced ventilation systems, such as air-to-air exchangers, heat-recovery ventilators, and energy recovery ventilators, both supply and exhaust air.

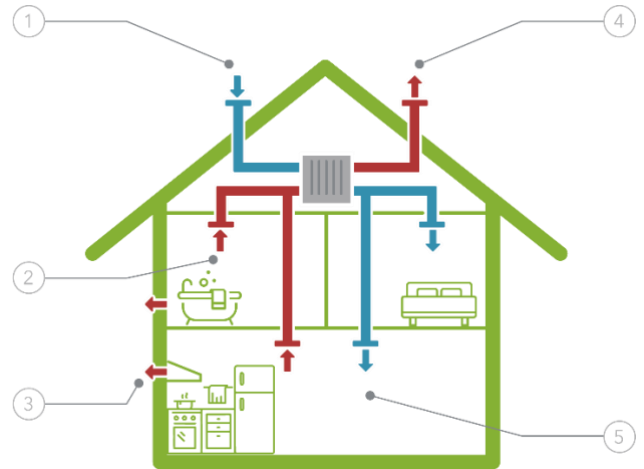
Ventilation Type	Pros	Cons
Exhaust Only Air is exhausted from the house with a fan	• Easy to install • Simple method for spot ventilation • Inexpensive	• Negative pressure may cause backdrafting • Makeup air is from random sources • Removes heated or cooled air
Supply Only Air is supplied into the house with a fan	• Does not interfere with combustion appliances • Positive pressures inhibit pollutants from entering • Delivers to important locations	• Does not remove indoor air pollutants at their source • Brings in hot or cold air or moisture from the outside • Air circulation can feel drafty • Furnace fan runs more often unless fan has an ECM (variable-speed motor)
Balanced Air Exchange System Heat and energy recovery ventilators supply and exhaust air	• No combustion impact • No induced infiltration/exfiltration • Can be regulated to optimize performance • Provides equal supply and exhaust air • Recovers up to 80% of the energy in air exchanged	• More complicated design considerations • Over ventilation unless the building is tight • Cost

Heat and Energy Recovery Ventilation Systems

Heat recovery ventilators (HRVs) and energy recovery (or enthalpy recovery) ventilators (ERVs) both provide a controlled way of ventilating a home while minimizing energy loss by using conditioned exhaust air to warm or cool fresh incoming air. The main difference between an HRV and an ERV is the way the heat exchanger works. With an ERV, the heat exchanger transfers water vapor along with heat energy, while an HRV only transfers heat. The ERV helps keep indoor humidity more constant, however, in very humid conditions, the ERV should be turned off when the air conditioner is not running.

Air-to-air heat exchangers or HRVs are recommended for cold climates and dry climates. ERVs are recommended for humid climates. Most ERV systems can recover about 70%–80% of the energy in the exiting air. They are most cost effective in climates with extreme winters or summers, and where fuel costs are high. ERV systems in cold climates must have devices to help prevent freezing and frost formation.

1. Fresh air drawn from Outside
2. Moisture-laden air extracted from wet zones
3. Exhaust to Exterior
4. Contaminated air into atmosphere
5. Fresh warm air delivered into the property



How Proper Ventilation for W.S. Eco-Home was calculated

For a W.S. Eco-Home, the performance of the home will depend upon the tuning of two systems: the FRP shell and the Engines (HVAC including all fans + water heating). To create the best practices for W.S. units, details of both systems were taken from the plans or estimated based on cost-effective building practices, and put into two computer software:

- Elite RHVAC - a J heating/cooling load calculator
- REM/Design - a predictive energy modeler

To control the performance of any home, we must control its four elements: heat loss, airflow/pressure, moisture, and air quality. Generally, the three things we can use to improve control are air sealing, insulation, and HVAC upgrades.

Performance analysis from computer models

Based on the panelized structure and the application of spray polyurethane foam (SPF), it's likely that all **W.S. Eco-Homes** will be airtight enough to meet all airtightness targets in future energy codes, which will future-proof them in that regard. However, the use of sliding doors and windows makes it very likely that all the air leakage will occur around those. Well-built windows are essential to attain the highest energy efficiency in a **W.S. Eco-Home**. Because of the substantial airtightness of the home, special attention should be paid to pressure equalization. In a small and/or tight home it's very easy to cause pressure imbalances with exhaust fans that can lead to moisture and air quality problems.

Bathroom Exhausts

The bathroom must have an exhaust fan to remove moist air, but due to the pressure fragility, it's recommended to install a whole-home ducted balanced energy recovery ventilator (ERV) to remove all the stale air in the house from the bathroom, over the shower. The incoming fresh air can then be delivered, preconditioned, to the bedroom where occupants will spend at least 8 hours per day (and also to the main room, if another duct is feasible). There will then be a purposeful pressure imbalance, sending a tidal movement of fresh air from the living spaces into the bathroom, and then to outdoors. The median airflow for the ERV should be around 30 CFM, with an option to dial it up or down based on occupant preference.

Kitchen Exhausts

Kitchen exhaust must go directly outdoors because of grease, but pressure equalization is still critical. Whether the make-up air pathway is connected to the kitchen directly beneath the cooktop or ducted through the HVAC system, pressure relief must be installed. A fan-powered, pre-heating makeup air system from Fantech would be ideal. It's small, quiet, and is reactive to the pressures in the home. For more information about Fantech's makeup air system you can refer to the next link: https://www.fantech.net/fileadmin/user_upload/fantech/Support/Media_Center_USA_Files/e1574-makeup-air-system.pdf

Another option is to use a passive Broan 'hole-in-the-wall' approach. The online Broan calculator recommends three 8-inch plus one 6-inch round ducts with mechanical dampers. That may not apply to all models since it requires a lot of wall space. For the exhaust hood we recommend an attractive, simple, quiet, and not too powerful unit like the Broan APE130SS.

Effect of Soil type and moisture on R Value

A baseline thickness of 5.5" thick for the closed cell spray foam applied to the wall/ceiling structure will provide an R-value of approximately 33. This can be adjusted through variations on the thickness of the insulation and on the type of spray foam.

Unless the type of soil is tightly controlled it is best to disregard the insulation value of soil for energy efficiency calculations because of variability due to moisture, mineral content, etc. The chart below is from a study by University of Kentucky on below-grade construction, and it corroborates other sources that estimate the R-value of soil at approximately 0.5 but floating up and down from there: If the type of soil is controlled an extra R-6 for every 12 inches of soil can be added to the wall/ceiling insulation calculations.

Effect of Windows in Energy Efficiency

	K	$R = \frac{1}{K}$	Inches Equivalent to 1 ft of earth material		
	Thermal Conductivity $\frac{Btu}{ft \cdot hr \cdot ft^2 \cdot OF}$	R-value of 1 ft of earth	Rock Wool R=2.92/inch*	Fiberglass R=2.17/inch*	Cellulose R=3.8/inch*
			inches	inches	inches
Very dry soil	0.1-0.2	5-10	0.14 to 0.29	0.19 to 0.38	0.11 to 0.22
Wet soil	0.7-2.0	0.5-1.43	0.014 to 0.041	0.019 to 0.055	0.011 to 0.0314
Dry sand	0.1	10	0.29	0.38	0.22
Wet sand	1.0	1	0.029	0.038	0.022
Sandy clay (15% moisture)	0.6	1.67	0.0477	0.0641	0.037
Organic soil	0.8	1.25	0.036	0.048	0.0275
Granite rock	0.26	3.85	0.1099	0.1478	0.0844

*R values advertised by insulation company. Thermal Insulation, Inc. Seneca, SC.

Table 1.-Soil conductivity values and R-values of 1 ft of earth insulation and thickness of equivalent man-made insulation

The weakest link in any building system defines performance, and in **W.S. Eco-Homes** units that have panoramic windows, this is the weak link. The current spec for window performance is approximately U-0.3 and 0.3 SHGC, which is the biggest source of heat loss by far in the enclosure, which will work fine for subtropical climates. For areas with higher temperature oscillations U-0.2 and 0.14 SHGC windows and sliders would be much better suited to the rest of the enclosure. Higher spec windows are essential if the goal is to meet the 2012 or 2015 International Energy Conservation Code (IECC).

Since the windows and glass doors are proportionally huge in many models of **W.S. Eco-Homes** - over 40% window-to-floor ratio (normal high-performance homes are around 20%), the wall enclosures around the windows can be filled with 1.5" of Extruded Polystyrene (XPS) Foam Board in all models, with an extra 1" XPS added continuously outside or inside the framing, for an overall R-value of 12.5. Compared to the main enclosure walls with R-33 of SPF, this represents low insulation, and high heat loss problem. Whenever temperature oscillations are high, and performance control is important, owners may want to reconsider using large windows in favor of European Spec smaller windows - where panels replace the outer glass.

Effect of windows in Energy Efficiency

Window placement should be even in all directions (N-S-E-W), to attain what in load calculation is described as Adequate Exposure Diversity. When the planned orientation of a **W.S. Eco-Home** exceeds the adequate exposure diversity test, it makes it unnecessarily hard on the HVAC system to make up for severe fluctuations to the comfort indoors because of the sun coming in through the windows. Since there are situations where the unit's orientation cannot be controlled, the size of the heating/cooling system required needs to be more significant. In these situations, awnings over the arches are **HIGHLY RECOMMENDED**.

Insulated Slab

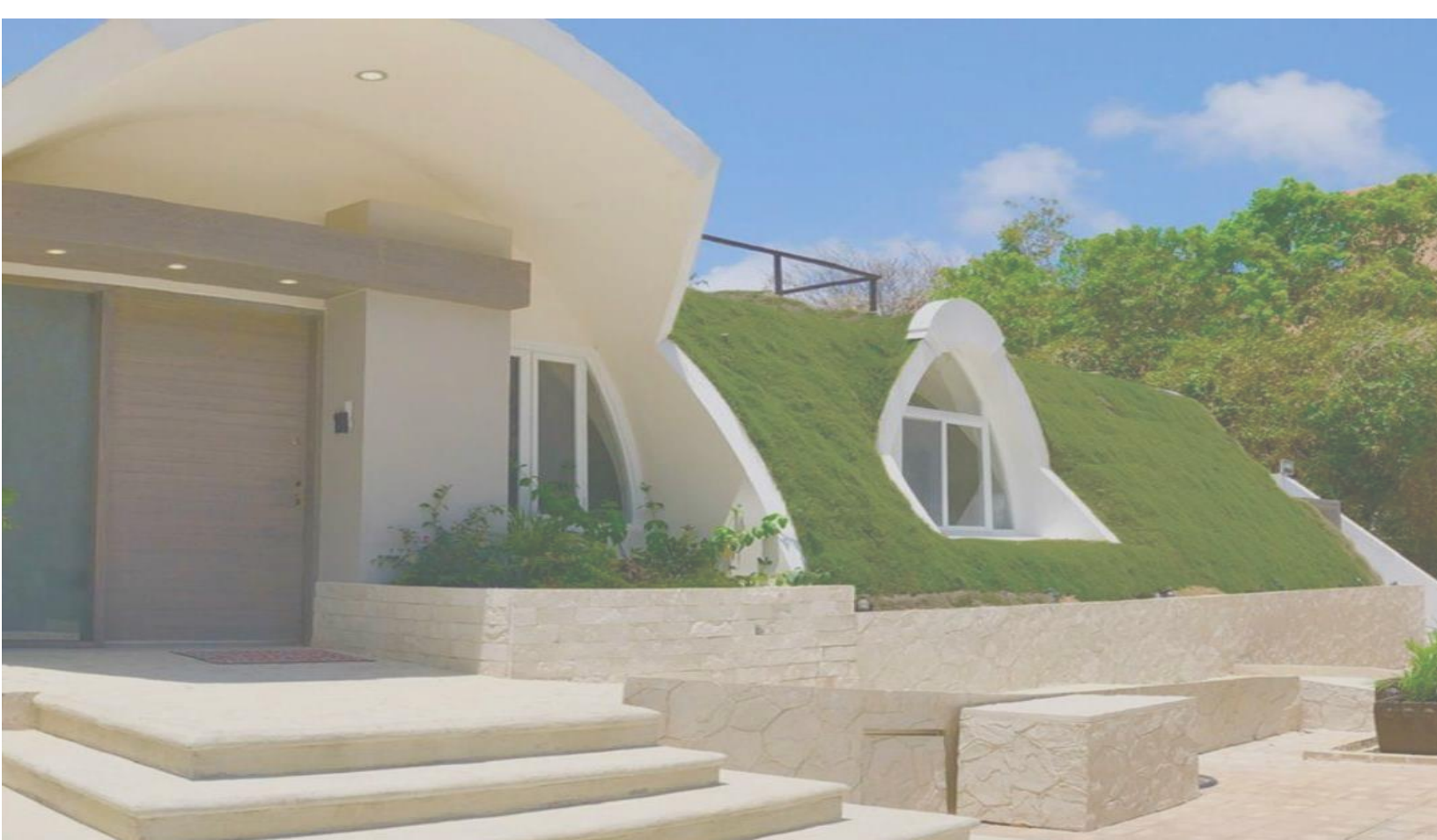
Lack of foundation insulation on below-grade and under slab projects can account for up to 25% of a structure's total heat loss. Insulating properly below-grade can also combat heat loss and help each structure reduce heating and cooling bills by 10-20%. The standard building code slab being insulated underneath and at the edge with 2" of XPS foam will provide an R-value of 10. This solution may often leave a significant thermal bridge through highly conductive concrete exposed to the outside or the soil near the perimeter.

A higher performance solution - values between R-40 and R-50, require 6 to 10-inch-thick insulation depending on the material used, to be placed under the entire slab including the footing. Because thick insulation can be difficult to detail, edge insulation is often reduced to a depth of about two inches, leaving a significant source of heat loss. That should be avoided. Thermally, it's best to place insulation on the exterior surface of the foundation. Any exterior rigid insulation that shows above grade must be protected from physical damage and sun exposure.

Air Quality Monitoring

Monitoring the air quality should be of primary importance in these homes- smaller, tighter homes are inherently more rigid and less flexible to fluctuations in behavior and weather. There is a simple answer for your homes:

- Foobot is a Wi-Fi monitor that test continuously for temperature, relative humidity, carbon dioxide (CO2), particulates and VOCs. It will send text messages when any of these exceed targets you set.
- Defender low-level carbon monoxide monitor should be installed if any fuel- burning appliances are installed inside the enclosure (doesn't matter for the mechanical shed).
- Corentium radon monitor will show a 1-day, 3-day, and 7-day radon level, which will give your homeowners peace of mind.



APPENDIX B – ADHESIVES COMPARATIVE TABLE

	Loctite PL Premium	Sikaflex 552	Sikaflex 11 FC	Sikabond	Masterweld 948	Sikaflex 1A
Uses	Construction adhesive	Structural adhesive	Adhesive and sealing compound	Construction adhesive	Polyurethane adhesive	Elastomeric joint sealant/adhesive
Chemical base	Polyurethane	One-part Silane Terminated Polymer	Special moisture-cured polyurethane	Polyurethane	Polyurethane	Polyurethane
Tensile strength (ASTM D412)	512 psi (3.5 N/mm ²) Substrate failure	435 psi	225 psi	225 psi	222 psi	175 psi
Tack free time	30-45 min	40 min	1 to 2 hours depending on the climate	1 to 2 hours, depending on the climate	Up to 1 hour	3 to 6 hours
Elongation at break (ASTM D 412)	200 to 300%	300%	600%	600%		
Tensile lap-shear strength		300 psi	165 psi		240 psi	
VOC	45 g/L			33 g/L	45 g/L (Low VOC)	
Datasheet	https://www.buildsite.com/pdf/pl/Loctite-PL-Premium-Polyurethane-Construction-Adhesive-Product-Data-1868305.pdf	https://doc.jamestowndistributors.com/userportal/pdfs/SIKA_Tech_sheets/Sika_Sikaflex_552_TDS.pdf	https://www.dropbox.com/s/cvboj1t37bgosf6/SikaFlex%C2%A%E11FC.PDS.6.8.20.pdf?dl=0	https://www.dropbox.com/s/e1jzfle3lhuhdkv/SikaBond_product_data_sheet.pdf?dl=0	https://www.dropbox.com/s/njc45zwbbeuyj3r/basf-masterweld-948-tds.pdf?dl=0	https://www.dropbox.com/s/6vgxseenocixgei/sikaflex_-1a.pdf?dl=0
Volume (Vol. Cartridges)	295 ml	300 ml	300 ml	301 ml	313 ml or 828 ml	300 ml
Price	\$ 6.90	\$ 14.85	\$ 6.61	\$ 15.97	\$ 13.39	\$ 10.95
	Hd supply solutions	Strobelssupply	Coast alone	Home depot	Tools4flooring	Amazon



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PRODUCT DATASHEETS

The following technical datasheets are listed in order of appearance on the *System Assembly & Installation Manual*:

- Sikaflex®-552
- SikaBond® Construction Adhesive
- Masterweld 948 ®
- SIMPSON SET-XP®
- HILTI HIT-RE 500-SD
- HILTI HIT-HY 200
- POWERS PE1000+™
- HILTI KWIK Bolt TZ Expansion Anchor
- HILTI HDA Undercut anchor
- HILTI HSL-3 Heavy-duty Expansion Anchor
- SIMPSON Strong-Bolt™ 2 wedge anchor
- POWERS Power-Stud® +SD1
- POWERS Power-Stud® +SD2
- POSSEHL POSSALC325 C-20
- Ames'® Blue Max®
- Sika® MultiSeal® tape
- Sika BlackSeal Plus
- POLYURETHANE FOAM
- AC50 staple fiber
- XYPEX ADMIX C-500/C-500 NF
- Firefree 88®
- FireGuard® E-84
- 3M™ Dual Lock™ Reclosable Fastener