
BUILD YOUR OWN
SHIPPING
CONTAINER
HOME
THE BEGINNER'S GUIDE

1. About the Author
2. About the Guide
3. Introduction
4. History of Shipping Containers
5. The Good News
6. The Less-Good News
7. Shipping Container Basics
8. Types of Shipping Container
9. Anatomy of a Shipping Container
10. Buying Used Containers
11. Buying New Containers
12. Working with an Architect
13. Dealing with Authorities
14. Planning Department
15. Securing a Building Permit
16. Shipping Container Sustainability
17. Passive Solar Design
18. Container Modifications
19. Joining and Stacking Containers
20. Footings/Foundations
21. Working with Weathering Steel
22. Insulation
23. Windows and Doors
24. Roofing
25. Case Study #1
26. Case Study #2
27. Case Study #3
28. What Next
29. Resources

# About the Author

## It's not easy to write in the third person...

Brodie Norris has been obsessed with houses since preschool. No, really. Here's a picture his Mum found of one of his early designs. Based on a 20' high cube container (we're pretty sure)...

After filling that gappy smile with adult teeth, Brodie pursued his love of (shipping container) houses by undertaking a degree in architecture, but realized a lot too late that involved designing boring things like museums and airports (bummer).

More recently, Brodie took his love of house porn to the next level -- establishing the website Lunchbox Architect. The popular site is dedicated not just to shipping container houses, but to innovative and affordable architecturally designed homes of all kinds.

# About the Guide

While I've attempted to give you a good overview of how you might build a shipping container home, there are so many individual preferences, needs, and approaches, it is impossible and impractical to cover them all.

That said, this guide along with the accompanying resources section is a living beast. The resources section in particular will be constantly updated with new information and additional resources. And the best bit? It's all based on what you want! Shoot me an email (hello@lunchboxarchitect.com) if you have any ideas or questions about shipping container homes and I'll do my best to answer your question and include any additional information in the resources section.

We're a community of shipping container home enthusiasts. We can learn from each other, share what we know and help to change the landscape of domestic building with this nontraditional technique.

So don't be shy! Let me know what you want to see in future editions of this guide, and what you would find helpful in the resources section. Here are some of my ideas, let me know what piques your interest: Sample Plans and Example Documentation, In-depth Interviews with Shipping Container Home Owners, Typical Details, Product Recommendations.

# Introduction

If you've used the internet recently (and I know you have), you will have noticed there are literally figuratively container loads of popular articles like "23 Surprisingly Gorgeous Homes Made From Shipping Containers" and "This Rusty Shipping Container Seems Abandoned. But Look Inside... It's Actually A Ravishing Home!" I didn't realise we described homes as 'ravishing'. But apparently we do.

Yep. Shipping Container Houses are all the rage on the internet. And for good reason. With a bit of skill, a shipping container can be transformed into a beautiful, low-cost, environmentally friendly home.

I say a bit of skill because, despite what some advocates (read: marketers) would have you believe, building a container home isn't much easier than building a traditional house. Because it's an unconventional building style in many ways it's even harder!

But don't worry. That's what this guide is for - to clearly explain the potential pitfalls and give you the skills to tackle your container project with confidence.

Believe it or not, the basics of Shipping Container Home design aren't actually about the peculiarities of building inside a shipping container at all. What's more important is to consider your site, your needs and how to balance what you want with the constraints of a small space.

Designing a shipping container home is more about designing for small, constrained spaces.

This guide contains a lot of general advice about designing and building your own home. While its focus is ways you can utilise used shipping containers as the structure for an affordable home, you might ultimately choose to use a different construction method for your project. Not to worry, we'll cover enough general planning and building advice to help you, even if you don't end up getting those three used shipping containers delivered to your freshly prepped site.

Ultimately you might decide that a shipping container home is not right for you. That's okay. A lot of the information in this guide can be applied to any type of

That's okay. A lot of the information in this guide can be applied to any type of construction. So read through it anyway, because even if you decide to buy a kit or prefab home, or build a custom house in a more traditional method, there is still important information about the design process, obtaining permits and basic construction principle which will help you with your project.

# History of Shipping Containers

Think about the towering stacks of containers that line the shores of busy docks. They're probably full of the things we tend to take for granted - cheap consumer electronics from China, high quality marble tiles from Italy, or even fruit straight from the orange fields of California. None of this would be possible without the modern shipping container.

Believe it or not, the standardized shipping container we know today has only been around for about 50 years. Prior to this, poor old 'longshoremen' would load and unload ships full of bales, sacks and barrels using systems of pulleys, hooks and a lot of manpower. A single ship full of an average of 200,000 pieces of cargo would take a week to load and unload! Thanks to the standardized shipping container, turnaround time, theft, damage to goods and costs all went down.

We have a man named Malcolm McLean to thank for the relative efficiency and reliability of our modern-day shipping and transport networks. He patented a container which was physically strong -- with reinforced corner posts to allow for craning and stacking.

Since McLean's original design the container has evolved to become an international standard. Companies have refined the containers design to be stronger, lighter, cheaper to manufacture and more resilient in order to save money and time. Today we have a highly refined shipping container that is perfectly suited to its purpose and allows the transportation of good all around the world.

Image Source

It's only in the recent past the potential for shipping containers to be used for construction was realised.

Phillip C. Clark filed for a United States patent on November 23, 1987 described as "Method for converting one or more steel shipping containers into a habitable building at a building site and the product thereof". This patent was granted August 8, 1989 as patent 4854094. The diagrams and information contained within the documentation of this patent appear to lay the groundwork for many current shipping container architectural ideas.

In recent years the popularity of shipping containers as architecture - especially as affordable housing - has exploded. It seems the potential of disused contianers for housing is being explored. And the future of shipping contianers will involve a myriad of creative architectural applications. Perhaps your future home will be included in this future!

# The Good News

## Benefits of building a shipping container home

Using one or more shipping containers as the base for a home building project has some massive benefits;

- Designing and building a shipping container house is an affordable alternative to traditional building methods. It's a great base to start with. After all, you start with a strong steel structure, so you can save a lot of time and money on preliminary works and framing.
- Shipping containers can be purchased relatively cheaply once they've reached the end of their life cycle. So you start with a strong, steel structure which can save a lot of time and money compared to building this initial framework from steel or timber.
- Containers are inherently earthquake and hurricane proof. Once modified they lose this inherent strength, but with the help of an engineer, you can have a disaster proof structure.
- The container's modularity allows for a number of configurations once you start using more than one container.
- It's a great way to up cycle. Instead of sending the container to the scrap heap, using it as the base of a house represents a sustainable use of our precious resources.
- Plus, they're fun! You only need to take a look at some of the inspirational designs people have already achieved to realise that this unconventional building technique is great fun.

# The Less-Good News

## Drawbacks of building a shipping container home

You've probably heard that shipping containers are the miracle home solution: They're cheap. They're ridiculously easy to build. They're green. They're freely available. 'Shipping companies are practically giving the things away, you know'!

Forget all that.

Like most of the things you hear on the internet that sound too good to be true. It's all, well, too good to be true...

- At just 2.4 meters wide and 2.1 meters high internally, shipping containers are unquestionably small. Can you make a workable house in this space? Absolutely! But you'll have to work hard to make sure that every millimetre counts. You won't have the luxury of just making it a bit wider if you're working to a container's dimensions.
- It can also be expensive and difficult to get a beaten up shipping container into a suitable condition for building.
- Serious modifications to the structure come at a price. If your plan involves removing a lot of walls, serious cantilevers or other complicated modifications, it may be cheaper and easier to start from scratch with a more traditional building method.
- As with any unconventional building method, it can be difficult to find tradespeople familiar with this type of construction. And even when you do find a willing and able contractor they are probably more expensive than your average builder.

# Shipping Container Basics

## Shipping Contianers 101

Intermodal containers, ISOs or shipping containers. No matter what you want to call them, if you want to build a house out of one of more shipping containers, it's important to get your head around the basics. Let's get to know the humble shipping container.

Firstly, here are some shipping container basics:

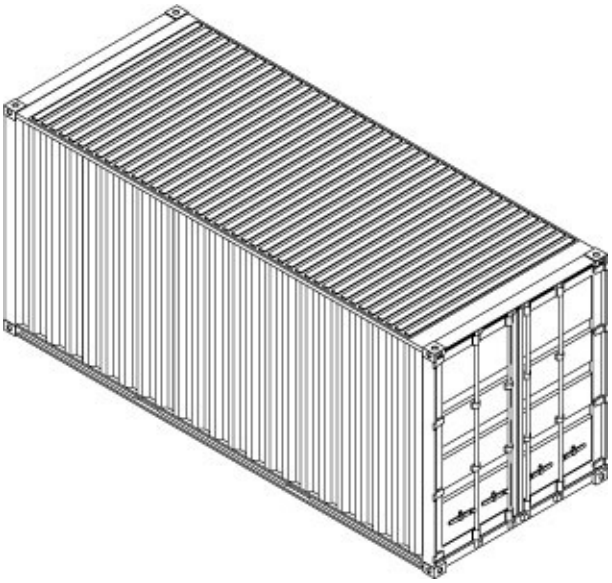
- Also known as Intermodal Containers or ISO Containers.
- Two commonly used lengths -- 40 feet (12 m) and 20 feet (6 m).
- Two standard heights -- 8 feet 6 inches (2.6 m) to 9 feet 6 inches (2.9 m).
- 8 feet (2.4 m) wide.
- Modular design creates a lot of configuration options.
- Constructed entirely from hard-wearing, corrosion resistant Cor-ten steel.
- Designed to be water tight, transportable, and durable.


Image Source

# Types of Shipping Container

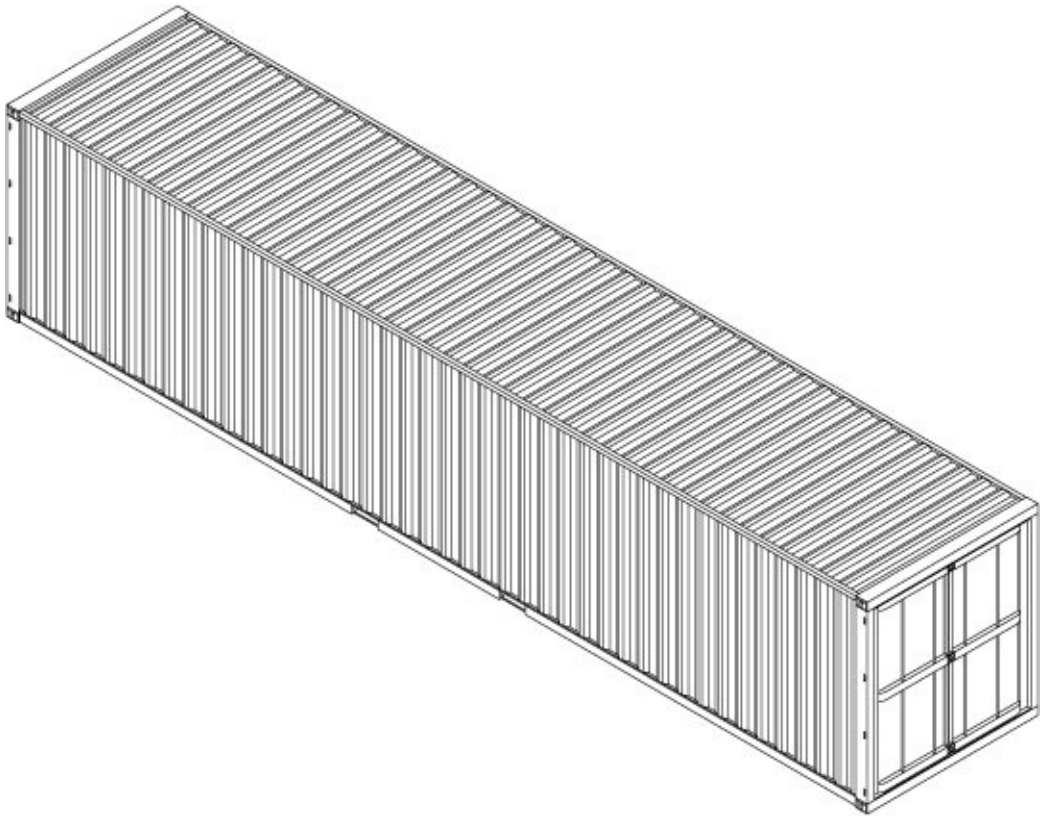
## Choosing the best container(s) for your project

There are five types of shipping container worthwhile discussing in this guide. Depending on the aims of your project, budget and personal style, you could use any one (or a combination) of these containers.



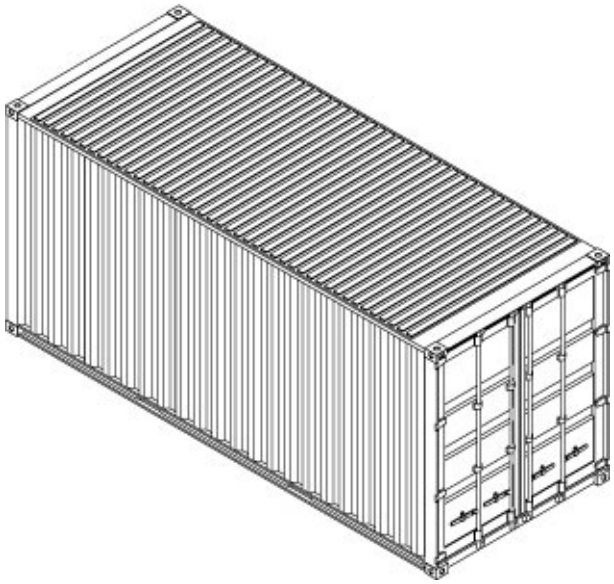
### 20' Standard

Often spotted as storage containers, the 20' Standard is big enough to be used as a home office, guest room or self-contained studio apartment.



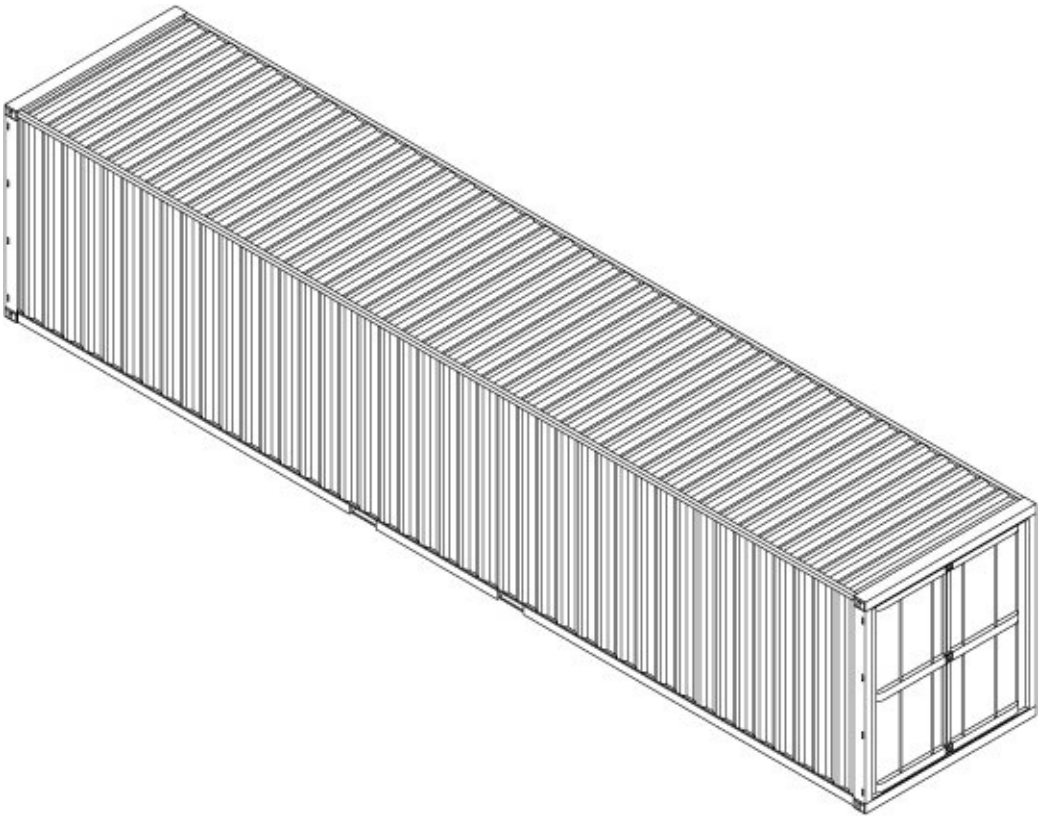
**40' Standard**

The 40' Standard is what most people are thinking when they imagine a shipping container. Twice as roomy as its 20' little brother. With dimensions of 12.192 m x 2.438 m x 2.591 m, it's long, narrow, and (by housing standards) the ceiling is low.



**20' High Cube**

The 20' High Cube is the same width and length as the 20' Standard Container, but it's a whole 300 mm higher (good news for tall folk and those looking for a bit more volume in their container. And, like hair, small spaces always look better with more volume).



**40' High Cube**

You guessed it - the 40' High Cube is just like the 40' Standard (but higher).

**'Reefer'**

A reefer is a pre-insulated, refrigerated shipping container. This is where it gets the name 'reefer'. Being pre-insulated it has some benefits for use as housing (saving time and money insulating). However it is constructed using polystyrene sandwich panels (the type used to make cool rooms) in a post and beam method. That means it's not a full steel structure like traditional containers. If you're after that classic container look, you'll want to steer clear of this type.

# Anatomy of a Shipping Container

## Dissecting the ubiquitous steel box

If you're planning to build your home from one or more of the things, it makes sense to understand what's going on under the corrugated skin of the world's most ubiquitous steel box:

### 20' Standard Container Structural Components

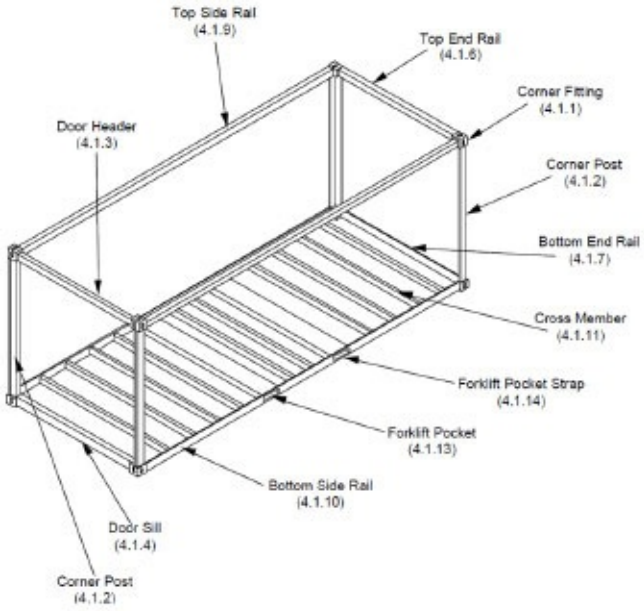



Image Source

### 20' Standard container Exploded Axonometric

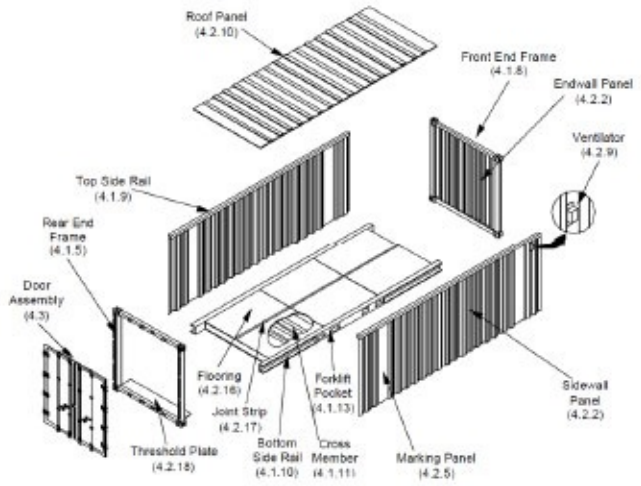



Image Source

4.1.1 Corner Fitting. Internationally standard fitting (casting) located at the eight corners of the container structure to provide means of handling, stacking and securing containers. Specifications are defined in ISO 1161.

4.1.2 Corner Post. Vertical structural member located at the four corners of the container to which the corner fittings are joined.

4.1.3 Door Header. Lateral structural member situated over the door opening and joined to the corner fittings in the door end frame.

4.1.4 Door Sill. Lateral structural member at the bottom of the door opening and joined to the corner fittings in the door end frame.

4.1.5 Rear End Frame. The structural assembly at the rear (door end) of the container consisting of the door sill and header joined at the rear corner fittings to the rear corner posts to form the door opening.

4.1.6 Top End Rail. Lateral structural member situated at the top edge of the front end (opposite the door end) of the container and joined to the corner fittings.

4.1.7 Bottom End Rail. Lateral structural member situated at the bottom edge of the front end (opposite the door end) of the container and joined to the corner fittings.

4.1.8 Front End Frame. The structural assembly at the front end (opposite the door end) of the container consisting of top and bottom end rails joined at the

door end) of the container consisting of top and bottom end rails joined at the front corner fittings to the front corner posts.

4.1.9 Top Side Rail. Longitudinal structural member situated at the top edge of each side of the container and joined to the corner fittings of the end frames.

4.1.10 Bottom Side Rail. Longitudinal structural member situated at the bottom edge of each side of the container and joined to the corner fittings to form a part of the understructure.

4.1.11 Cross Member. Lateral structural member attached to the bottom side rails that supports the flooring.

4.1.12 Understructure. An assembly consisting of bottom side and end rails, door sill (when applicable), cross members and forklift pockets.

4.1.13 Forklift Pocket. Reinforced tunnel (installed in pairs) situated transversely across the understructure and providing openings in the bottom side rails at ISO prescribed positions to enable either empty capacity or empty and loaded capacity container handling by forklift equipment.

4.1.14 Forklift Pocket Strap. The plate welded to the bottom of each forklift pocket opening or part of bottom siderail. The forklift pocket strap is a component of the forklift pocket.

4.1.15 Gooseneck Tunnel. Recessed area in the forward portion of the understructure to accommodate transport by a gooseneck chassis. This feature is more common in forty foot and longer containers.

**4.2 Walls, Roof, and Floor.**

4.2.1 Fibreglass Reinforced Plywood (FRP). A material constructed of laminates of fibreglass, polyester resins, and plywood, also known as sandwich panel.

4.2.2 Sidewall Panel. Corrugated or flat sheet steel, a riveted or bonded aluminium sheet and wall post assembly, FRP, foam and beam, aluminium, or honeycomb material that forms the side wall or end wall.

4.2.3 Wall Post. Interior or exterior intermediate vertical component to which sheet aluminium or steel is riveted or welded to form a wall panel.

4.2.4 Wall Beam. Encapsulated vertical component to which sheet aluminium or steel is bonded to form a wall panel. This is found in foam and beam panels.

4.2.5 Marking Panel. A side wall panel of a corrugated steel configured with a flat portion used for the display of markings and placards. (4.2A)

4.2.6 Lining. Plywood or other like material attached to the interior side and end wall to protect the walls and/or cargo and facilitate loading operations.

4.2.7 Lining Shield. A strip of thin metal installed at the bottom of the interior walls to protect the lower portion of the lining from damage by materials handling equipment during loading or unloading operations.

4.2.8 Kick Plate. A common name for a lining shield installed on the lower portion of the interior front end wall.

4.2.9 Ventilator. Two or more devices permanently attached to the side or end wall panel that provides openings for the exchange of air (but not water) between the outside and the container interior.

4.2.10 Roof Panel. Corrugated or flat sheet steel, sheet aluminium, FRP, or foam and beam and aluminium honeycomb panel that forms the top closure of the container.

4.2.11 Roof Bow. Lateral non-structural member attached to the top side rails and supporting the underside of the roof panel. Roof bows used with removable cover (tarp) assembly are unattached. Not all container designs require roof bows.

4.2.12 Roof Beam. Encapsulated horizontal component to which sheet aluminium or steel is bonded to form a roof panel.

4.2.13 Roof Reinforcement Plate. An additional metal plate on the interior or exterior of the roof panel adjacent to the top corner fittings that provides protection of the roof panel or top rail components from misaligned handling equipment.

4.2.14 Tarp. Jargon for "tarpaulin" which is a waterproof and flexible fabric used for covering the top of an open-top container. This covering is referred to as a "Tilt" in some countries.

4.2.15 TIR Cable. Plastic sheathed wire rope that is designed in accordance with TIR customs convention and is threaded through the welded loops on the sides, end panels and door panels of an open-top container to secure the tarp.

4.2.16 Flooring. Material that is supported by the cross members and bottom rails to form a load bearing surface for the cargo. The flooring is usually constructed of laminated wood planks, plywood sheets, or other composition material and is screwed or bolted to the cross members. Some containers have welded steel or aluminium flooring, sandwich panels or a combination of metal and wood.

4.2.17 Joint Strip. A formed steel or aluminium strip (usually hat-shaped section) installed between joints of the plywood sheet flooring or joints of the plywood sheet lining to help integrate and support the edges of the plywood.

4.2.18 Threshold Plate. Plate forward of the door sill to protect the entrance area of the container floor. This plate is commonly referred to as a crash plate.

4.2.19 Steps. Folding steps are found on some ISO Shelters and are used to gain access to the roof. They must be folded up prior to transporting shelter.

4.2.20 Sandwich Panel. A type of fixed or removable panel construction used in ISO Shelters consisting of a thin inner and outer sheet aluminium skin, bonded or fastened to a core constructed of either honeycomb or structural foam and aluminium beams.

4.2.21 Striker Plate. An additional metal plate on the exterior of the roof panel adjacent to the top corner fittings that provides protection to the roof panel or top rail components from misaligned handling equipment.

4.2.22 Sling Pad. An additional metal plate on the exterior of the roof panel located in the centre of the roof panel that provides protection to the panel from lowered handling equipment.

Source: http://www.residentialshippingcontainerprimer.com/

# Buying Used Containers

## Separate a Bargain from a Rip Off

Companies like Maersk, "K" Line and Evergreen build containers and lease them so people can transport cheap trinkets (and even some important goods) all over the globe. It's a rough and tumble world on the high seas, so the company that owns the container constantly assesses whether it would be more cost-effective to continue maintaining and reusing the container, or to sell it off for the best price -- which is why you can pick up a cheap second-hand container at the end of its life cycle.

The price of the container depends entirely on its condition - the older it is, and the more it's been knocked around in transit, the cheaper it will be. The trade off here is that cheaper containers will take a lot of extra preliminary work to achieve a 'true' structure for construction.

Heavily used containers are likely to have a number of dents, significant corrosion and even gouges in the steel body. Obviously that's not a great starting point for your dream home.

Depending on the condition of the shipping container, you can pick one up for a few thousand dollars. Just make sure you inspect the container in person before buying to ensure you're getting good value for money.

Entering a container yard in the search for a second-hand shipping container is like walking into a second-hand car dealership. It pays to know what you're talking about, or you're bound to pay too much for a lemon! Ideally you should consult a marine surveyor or marine engineer to help you with your purchase as they will have an idea of an acceptable market rate and will know what defects to look for.

### Shipping Container Inspection Checklist

- Beware the freshly painted container! Often re-sellers will paint the container to increase the sale value. They may try to cover up signs of rust and corrosion. Look for areas where the paint is bubbling up or lifting away

as this is a sign of corrosion underneath.

- Does the inside of the container smell of mould? That's a sign of a roof leak. Get up on the roof and see if you can find where the leak might be coming from, or if any shabby patch jobs have attempted to fix the leak.
- What about the smell of chemicals? Containers see a whole range of contents over their lives. Strong cleaning chemicals can leach into the paint and that's not something you want to be living inside!
- Check underneath the floor. If the container has been stored on the ground, or directly on concrete it can have serious corrosion damage in the structural cross members which hold up the floor. You can inspect the floor by having the plywood floor lifted up, or the whole container can be lifted up by a forklift.
- Check on top of the roof. As mentioned, the roof can leak, but it can also be seriously corroded but not yet leaking, so it's worth checking.

# Buying New Containers

## If it sounds too good to be true...

If the idea of haggling with container agents for the best price doesn't appeal, there is another option that's growing in popularity.

You can avoid all the rust and the dents and the hassles of buying second-hand containers from container dealers and instead, have a custom-built shipping container delivered shiny and new from China. You can even have it made wider than a standard container. And if you're really patient and up for some organising, it can arrive fully fitted out and furnished, ready to drop onto site. Now that's convenient. What's more, architects and builders are demonstrating that this can be an economical way to provide affordable housing.

So why isn't everyone doing this?

Well, here's the catch. And it's a dirty big one.

Buying new shipping containers for domestic use is one of the biggest environmental sins there is. Environmentally, steel doesn't come cheap. It's the product of carbon intensive energy. So while reusing existing containers can make good environmental sense, as soon as you start custom making shipping containers for domestic use, all of the environmental benefits of up cycling a container at the end of its commercial life cycle go up in a stinky cloud of brown coal smoke.

For this reason I really do not recommend going down the new container route.

# Working with an Architect

An architect is not essential for a shipping container project, but she/he will certainly make your life easier! Okay, so I studied to be an architect. I run a website called Lunchbox Architect. It's fair to say I'm pro architect. And therefore, me advising that you should ABSOLUTELY hire an architect for your shipping container project might be viewed as a smidgen biased.

But let me argue the case regardless...

For one, architects are experts at dealing with small spaces and constrained circumstances, so they'll be able to help you realise a higher quality home.

The architect's job doesn't stop at the design, either. A full-service architect handles everything from the design through to managing the build and inspecting the quality of work. An architect can also help you navigate the red tape and bureaucracy of gaining approvals and permits for your project.

But let's be honest. Architects are renowned for their on-the-brink-of-bursting egos, their overblown budgets and their lack of practical understanding.

Some of this is totally fair. I've spent enough time with architects to have witnessed some dramatic clashes of ego. But there are just as many (if not more) quiet, humble and hard-working architects who work with their clients to develop a design that everyone is delighted with. Ego free.

It's an architect's job to ensure the project comes in on budget. So the idea of the prancing architect realising their creative dream at the expense of a verging-on-bankrupt client is undeserved.

And there are a number of checks and balances (not cheques and balances) that architects use to make sure a project stays on budget. In my experience, the majority of budget blowouts are due to changes to the scope of works during construction - changes which are approved (and the majority of times requested) by the clients.

As for a lack of practical understanding? Architects are optimists and like to challenge convention. And sometimes what seems like a stellar idea on paper, turns out to be an impractically difficult thing to actually build. This might make

turns out to be an impractically difficult thing to actually build. This might make them seem impractical, but provided there's a good architect-builder relationship, these issues should be sorted out before building even commences.

Architects usually charge a percentage of the building budget and their fee is staged through each phase of the design and building process. You can hire an architect for their full suite of services - from design through to managing with the builder during construction (contract administration), or you can just hire them for the design phase.

Choosing an architect is not always easy. You can contact your local chapter of the Institute of Architects in your country (AIA in USA and Australia, RBIA in the UK). The Institute can put you in contact with architects who work on the type and scale of project you're interested in. Feel free to meet with the architects before you commit to see if you feel comfortable with them and their approach.

# Dealing with Authorities

## Surefire Ways to Get The Stamp of Approval


One issue many people run into when building shipping container houses is difficulty gaining approvals and permits. Shipping container homes are still an experimental building technique, so council and building inspectors may be reluctant or uneasy in approving their construction. That said, there are numerous (an increasing) number of examples of shipping container homes around the world. With the help of an architect, engineer and some research, you should have no problems setting their minds at ease.

Most councils, local governments and planning authorities will consider that dumping (or even carefully placing) a shipping container on your site 'development'. And when you're 'developing' your site, you'll need to obtain the relevant approvals.

In most cases this will mean a planning permit first and then a building before any work can commence. Of course different jurisdictions have different systems, so it's best to check with your local authority.

Navigating the reams of red tape required to gain approvals and permits for shipping container homes is something many struggle with. Many more naively choose to ignore the law and build their structures illegally -- a decision they will likely live to regret!

I'm not going to lie. Getting all the paperwork and approvals in place is not easy and rarely straightforward. It's a task that a registered architect will be able to help you with, but if you've chosen to go it alone, the following pages will give you an overview of the process and what you can expect. Every planning and building authority is different and the rules change regularly enough to make it

difficult to give specific advice. If you have specific questions, feel free to contact me and I'll do my best to answer.

Before you even begin your project, it's essential to check with your local Planning and Building authority to see if what you are proposing is likely to be approved. You can often arrange a pre-planning meeting to meet with your designated planner to discuss your proposal. Use this meeting as an opportunity to flesh out the issues the planning department might have with your proposal. Then, either modify your design to address these issues, or come up with good arguments as to why you should be allowed to go ahead with your plans.

Local councils and planning authorities get a bad rap. They're not nearly as scary, bureaucratic or anti-development as your brother-in-law's mother's second-best friend told you.

And seriously, you can save yourself a lot of headaches down the track by taking the time to go through the process.

It is always better to seek permission first -- even if you have to strongly argue your case -- than to ask for forgiveness later. Often the only way you'll be 'forgiven' is if you remove the offending structure. And that means all your money and hard work either needs to be hastily relocated or face the wrecking ball. Trust me on this one.

# Planning Department

The planning department in your area will probably be pretty easy to win over. If you can present a well documented and clearly argued case for why your shipping container house is a suitable development, they should happily go crazy with the 'approved' stamp all over your application.

The easiest way to ensure success is to hire an architect, because they will handle the whole process for you. An added benefit of hiring an architect is they deal with planners and planning regulations all the time, so they'll design something that they're confident will be approved - a much better option than flying blind.

But if you've decided to go it alone, here are some tips to help you...

The best way to convince a planning department that they should allow your shipping container project is by showing them how 'normal' it will look and that it will meet their other requirements, such as floorspace, neighbourhood character *etc.* It's just a conventional house that uses and unconventional building technique.

Essentially you just have to set their minds at ease. Demonstrate that the container will undergo enough modifications to make it a habitable (comfortable, even) home.

You do this by preparing drawings. You should check with your planning department about their specific needs, but the drawings you prepare will likely need to contain information about the design of your building and the uses of each room. Check out the resources section for more planning drawing advice and examples.

# Securing a Building Permit

We've already discussed the importance of getting a structural engineer to approve any modifications to your container. Having these engineers computations will help set a building inspector's mind at ease and is an essential part of securing building permits for your project.

The building permit part of the approvals process usually requires submitting more detailed drawings about how you will actually build your shipping container home. Luckily, you're starting with a solid and structurally sound base, so as long as your modifications are ticked off by an engineer and you comply with footing regulations and other requirements, the building department should be happy that your home will be structurally sound.

The difficulty comes in by trying to get the container up to code in areas such as thermal performance, ventilation and lighting requirements, minimum floorspace *etc.*

You may need to have a thermal efficiency report prepared by an energy assessor as part of your build permit.

It's advisable to work with a private building inspector during the planning stages (an architect will hire a building inspector on your behalf). The building inspector will advise you on how you can make your design meet the relevant codes.

Check out the resources section for more information about securing a building permit.

# Shipping Container Sustainability

## Making it green...

Shipping Container Homes have been touted as a super sustainable way to build. While this can be true, shipping container homes are not inherently sustainable. They're made from steel for one, which is one of the most energy intensive materials we have. Think about it, first the ore has to be hauled out of the ground. And those oversized Tonka trucks aren't light on fuel. Then the ore has to be processed and refined. Then it has to smelted at high temperatures, achieved oftentimes by burning huge amounts of fossil fuels.

So the steel itself doesn't come cheap, environmentally speaking. shipping containers have what we call high embodied energy. A lot of energy - and therefore carbon emissions - went into creating that deceptively simple corrugated box.

But given the shipping container and its high embodied energy steel is at the end of its life cycle anyway and it would take yet more fossil-fuelled furnaces to recycle, it does make good environmental sense to up-cycle instead.

The exception to this principle is people who try to save themselves time and energy by buying new containers for their project. True, that will save effort 'truing' the container and fixing corrosion for building purposes. And a fresh off the production-line container does look shiny and enticing. But it comes at a huge environmental cost.

That's why, in the 'buying a new container' section I don't recommend you use a hot off the press container.

# Passive Solar Design

## Making it green...

> "In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This is called passive solar design or climatic design because, unlike active solar heating systems, it doesn't involve the use of mechanical and electrical devices." - Wikipedia

Would you believe a shipping container house using Passive Solar Design principles often doesn't need any additional heating or cooling? All it needs is free energy from the sun - not even fancy photo voltaic cells or complicated heat transfer systems. With a little planning, your shipping container home can certainly be a passive solar home too!

Think of how much money and energy you would save if you didn't have to pay for heating and cooling - 40% in most cases (and much more in some climates).

A Passive Solar House relies on six basic principles. If you get these principles right, you could eliminate your heating and cooling bills for good:

### Climate

Passive Solar Design principles vary depending on your climate. In the tropics, using the sun to heat your homes would obviously be a bad move. Instead, cooling and ventilation is much more important. Whereas in Alpine areas, the house will probably never need cooling to maintain a comfortable indoor temperature. Temperate climates fall somewhere in the middle, usually requiring heating in the winter and cooling in the summer.

So, based on your climate, a Passive Solar Design will look and behave differently. In the tropics, large overhanging eaves shade the shipping container home from the sun and ventilation is essential to keep the space cool. While in cooler climates, eaves are sized to let the low winter sun in to warm up the home, while blocking out higher summer sun.

### Orientation

## Orientation

Because Passive Solar Design relies on the movement of the sun, orienting your home correctly is essential. In Australia (and other countries in the Southern Hemisphere), the ideal location of windows for Winter heat gain is North, because the sun rises in the East and travels through the North sky before setting in the West.

In Europe, North America and other areas in the Northern Hemisphere, the opposite is true. The sun still rises in the East and sets in the West, but it travels through the Southern sky, so for maximum Winter sun, windows should face South.

If you're modifying the shipping container to have a large bank of windows on one long wall as many designs call for, you'd be wise to face these windows in the right direction for maximum passive solar gain.

## Shading

Let's not forget shading. In the tropics shading is important to keep the home cooler throughout the year. In the case of your shipping container home this might be achieved with a large overhanging roof. With the exception of the most frigid climates some level of shading is important in cooler climates as well to prevent overheating in Summer.

Because the sun is higher in Summer than in Winter, shading devices in temperate climates can be designed to block out the Summer sun, but still allow the Winter sun in.

Deciduous trees or creepers are another way to shade windows because they work in sync with the seasons. In Summer, lush green leaves will protect your home from the sun. In Winter the plant drops its leaves to let the sun shine in.

## Thermal Mass

Have you ever stepped on or touched concrete after the sun has set to find it's still toasty warm? That's because concrete is great thermal mass - it absorbs and then holds heat for a long time. Materials with high thermal mass (like concrete, brick and even water) are like a thermal bank account. When times are good and the sun is shining they'll absorb the heat energy. Then, when that heat disappears

the sun is shining they'll absorb the heat energy. Then, when that heat disappears (when it's cloudy or the sun has set) they'll slowly release that heat back into the atmosphere. When used in a home, this helps to moderate the temperature between the day and night.

The reverse is also true, if you cool down concrete or any other material high in thermal mass, it will stay cool for a long time, radiating that 'coolth' back into atmosphere.

When used correctly, thermal mass is a great way to store the sun's energy the keep the house warmer at night or when it clouds over. In summer (or tropical climates), the thermal mass can be used to keep the home cooler.

It can be hard to incorporate thermal mass into shipping container projects, because they are a lightweight construction. One way is to use a slab-on-ground foundation. By insulating the slab, it becomes a thermal mass for the house. Another technique would be to include a concrete bench top or even store rainwater in a tank inside the house.

**Ventilation**

In many climates, cooling is just as important (if not more important) as heating. So how does Passive Solar Design cool a house? The sun itself isn't very good at cooling!

The key is ventilation.

Passive ventilation replaces hot, stale air with fresh, cooler air. Techniques like the stack effect achieve this replacement very efficiently. Depending on the site and climate, you might also be able to capture natural cool breezes, like evening sea breezes, for example.

Our bodies are pretty good at moderating our own thermal comfort. Perspiration, for example helps to keep us cool. But perspiration only works when the sweat can be evaporated off our skin - enter ventilation. A decent breeze can keep us feeling comfortable even in extremely hot conditions.

So ensuring the shipping container home has good ventilation - particularly cross ventilation - and encouraging the air to be drawn into the home from the cooler, shady side of the house will keep the house cool and comfortable even during

the peak of summer.

Combine good ventilation with thermal mass and you can use the cooler night air to keep the house much cooler during the day.

**Insulation**

The final key principle of Passive Solar Design is insulation. Insulation in temperate and cooler climates is incredibly important. All our efforts to passively heat or cool the home will be lost if the home isn't well insulated from the outdoor temperatures. And without insulation, a shipping container house is just a hot (or cold) tin box! Included in this guide is an entire section dedicated to insulation because it's so important.

The type and extent of insulation will vary depending on your climate. Tropical climates will require little to no insulation -- perhaps just a reflective sheet like sisalation. While a very cold climate will need double or triple-glazed windows and very thick bulk insulation in the walls to keep the warm air inside. The difficulty with insulating a shipping container home is you generally need to pack out the walls on either the inside or outside to make enough room for the insulation's thickness.

It's particularly important in a Passive Solar Design to insulate the thermal mass from the outdoor extremes. This will help the thermal mass to moderate the temperature of your home day and night and season to season.

**Thinking About Passive Solar Design**

A good architect will consider Passive Solar Design as a matter of course. Passive Solar Design isn't a fancy additional extra. For the most part it doesn't cost any more - in fact over the life of your building it can save serious money. It's easy to achieve with a shipping container house, it just needs a little thought.

There's really nothing better than basking in warm, natural sunlight in your comfortable, efficient container home when it's freezing cold out, or opening up your house to cooling natural breezes on a warm Summer's night. Passive Solar Designed homes are more comfortable year round, cheaper to run, and much friendlier to the environment.

# Container Modifications

## Because no one wants to live in a steel box with no windows

I suspect the idea of your dream shipping container home doesn't involve spending your days confined in a narrow, cell-like box with no windows and large, heavy steel doors.

And if my hunch is correct, you'll need to modify your container to some degree. Cutting holes for new windows and doors or joining more than one container together, for example.

Let your imaginary angle grinder go nuts. But just keep a few things in mind...

Shipping containers are designed as a contiguous, self-contained structural unit. They have what's known as monocoque bodies, which means their corrugated steel skin acts in harmony with the structural frame to give the container strength, rigidity and the ability to carry floor loads far greater than a few humans and their double sofa bed.

In their original condition, shipping containers are over-engineered for human habitation.

But as soon as you cut a square hole for the perfect picture window, or (better yet) remove a whole side-wall for a floor-to-ceiling sliding glass door, you compromise the whole structural integrity of the container. Now, before you jump up and aggressively push this guide into your insinkerator, this isn't a deal breaker. Take a cursory glance at any of the successful container home projects and you'll see they've pulled off some serious modifications.

The important point is to be frugal with your modifications, because you may end up needing to add additional steel work or framing to take the load - extras that add up quickly. And always have a structural engineer assess your design. If you're dealing through an architect, the architect will consult an engineer on your behalf, but if you're handling the design, consult a structural engineer before planning any modifications.

Shipping containers are almost entirely made from steel. So it's a logical progression that any modifications will need to be performed by a steel worker

progression that any modifications will need to be performed by a steel worker (even if that steel worker is you). Modifications to the container will involve steel cutting, framing and welding.

Because steel fabrication is not in the toolbox of your average residential builder, there are costs associated with this type of work. Too minimise these costs, it's usually preferable to have any modifications and steel work done off-site before the container is delivered. You can often arrange these modifications with the container seller themselves.

In this case, once the container arrives at your site it will be ready for the more traditional trades like carpenters, plasterers, plumbers and electricians to do their work.

If you're planning to do the steel work yourself, make sure you read the section on weathering steel (the type of steel shipping containers are constructed from) to learn how to deal with this type of steel.

# Joining and Stacking Containers

## It's just like Lego. Except, not.

You've probably seen some pretty impressive shipping container architecture on the 'net and in the pages of glossy magazines.

You know the type I mean, huge overhanging cantilevers, cavalier stacks of differently sized containers and other wacky designs.

It's fun to let your imagination run wild when planning a shipping container home, and channel the Lego-obsessed 8 year-old within.

All of these creative stacking and arranging of containers is entirely possible, but unfortunately, it's certainly not economical. Or even easy.

The reason comes back to what shipping containers are actually designed for. We discussed that, over time, containers have evolved so that they are as efficient, light and strong as possible for the task they need to perform - carrying goods on ships, trucks and trains. The key phrase here is 'for the task they need to perform'.

Image Source

As soon as you start using containers in ways for which they weren't originally designed, you can run into problems. In fact, if you don't go through the right process of re engineering the containers based on your individual design, it can be downright dangerous. And I'm sure you're not keen on having a 40 tonne mass of metal crush you in your sleep.

When shipping containers are stacked in any way other than directly on top of each other, you start to exert unnecessary forces on parts of the container than may not be able to withstand those forces. Stacked directly on top of each other, shipping containers are hurricane proof. Stacked in unconventional arrangements and they become a very heavy house of cards!

But don't let that dash all your hopes. Anything is possible, but remember you'll need an engineer's advice and likely additional reinforcement to achieve any of the arrangements below.

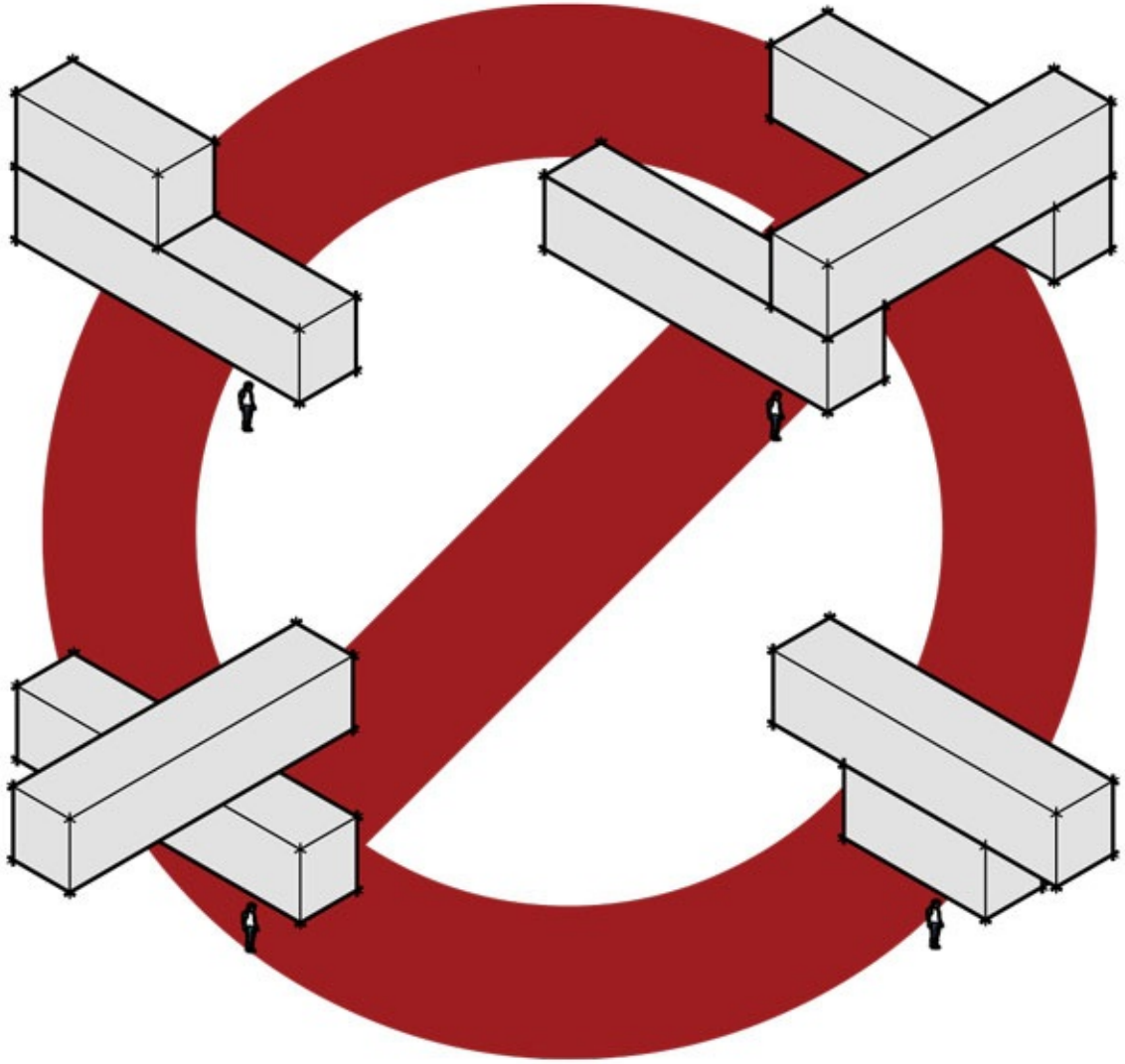


Image Source

Aether's San Francisco store looks very cool with a modest but impressive cantilever and a three container high stack. But the engineer has probably had to include a whole lot of structural steel to achieve this.

At a minimum there are additional beams to support the cantilever. These beams would have to continue under the stack at least another two-thirds of the length of the cantilever. Then, the corner posts of the bottom container would need to be strengthened, and additional steel added beside the window where the sidewall has been modified.

While this is all within the realm of possibility, you see how even relatively stable looking arrangements can quickly require significant modification - and expense - to be structurally sound.

The red lines on the image below indicate where additional structure was likely required.


Image Source

# Footings/Foundations

The footings and foundations for your project are going to depend a lot on your site conditions, soil type and the design of your shipping container home. But, whatever your needs it's important to get your footings right!

Your first step should be to get a soil test on your property. This will narrow your options for footings. Generally speaking there are only a few types of footing used in shipping container houses.

### Footing Options

- Slab on Ground
- Stumps/Piers
- Piles

But for now, lets assume your site has little to no slope and has soil with good bearing capacity. (Lucky you!) You have two main options:

### Slab or Stumps?

In my opinion, concrete stumps (piers) are the best solution for shipping container homes. While concrete slabs can be a good solution which can provide thermal mass for your home, it needs to be carefully designed to ensure moisture and consequently corrosion don't become an issue.

Even once we've narrowed it down to pier footings, there are variety of options. What you ultimately choose will probably have a lot to do with your engineer and builder's preferences and experience.

Here are the main types of piers available:

### Precast Concrete Piers

Precast concrete piers are easily available, durable and most builders will be familiar with their use. However, fixing the container to the precast piers isn't as straightforward as other options.

## Traditional Timber

Traditional timber piers are cheap and easily available. Like precast concrete piers, most builders will be familiar with their use. However, timber piers are less durable and, combined with termite protection, moisture prevention and difficulty with fixing the container, they don't represent the best solution for shipping container homes.

## Poured on Site Concrete Piers

Concrete piers poured on site are the best option for shipping container homes. There are two main methods for pouring the piers -using purpose built wooden forms, or using one of the many pre-made fibreform products. Fibreforms are the simplest and most appropriate choice. They have the benefit of coming in a range of diameters, perfect for situations where you're joining two or more containers at one point. A great way to fix the container to your piers is to set a steel plate into the pier and weld the container directly to the plate. This will help to prevent uplift and create a clean and durable connection. Your engineer will specify the amount of reinforcement required in the piers and detail the connections.

Keep in mind that when large parts of the side wall are removed, this compromises the structural integrity of the shipping container, making the floor beams more susceptible to deflection. To prevent a bounce effect in the completed home, you should add one or two mid-span piers along the long side of the container.

Also remember, if pouring mid-span footings the corner fitting of a shipping

Also remember, if pouring mid-span footings the corner fitting of a shipping container sits slightly below the bottom side rail, so allow for this in the height of the footings for a flush and perfect finish.

Concrete piers are usually poured and cured before the containers arrive. So it's super important to check and recheck your measurements and levels for a smooth delivery day. Having a crane sitting around while you modify footings gets pricy very quickly!

# Working with Weathering Steel

## Everything you need to know about Cor-ten

Weathering steel (or COR-TEN, the proprietary name to which it's often referred)was developed in the 1930s by the United States Steel Corporation. Weathering steel looks just like regular steel initially, but after exposure to water it develops a rust-like patina which actually protects the underlying steel from corrosion. This controlled corrosion was a valuable asset back when it was used primarily for railway coal wagons and remains an invaluable feature today.

Weathering Steel is used extensively for ISO shipping containers because of its inherent toughness and resistance to corrosion - even in extreme conditions like the salty, corrosive environment found on the back of a ship.

### How Does It Work

Weather-resistant steel works by controlling the rate at which oxygen in the atmosphere can react with the surface of the metal. Iron and steel both rust in the presence of air and water, resulting in the product of corrosion - rust, iron oxide. Non-weather-resisting steels have a relatively porous oxide layer, which can hold moisture and promote further corrosion. After a certain time (dependent on conditions), this rust layer will delaminate from the surface of the metal, exposing the surface and causing more damage.

Cor-Ten exhibits superior corrosion resistance over regular carbon steel as a result of the development of a protective oxide film on the metals surface that slows down further corrosion. Their yield strength allows cost reduction through the ability to design lighter sections into structures. These steels were designed, primarily to be used in unpainted applications where a reduction in maintenance costs, such as painting, were desired. Weathering steels are now being used in a variety of applications, including bridges, rail cars, transmission towers, chimneys and shipbuilding. It is also becoming increasingly popular with sculptors and as an architectural feature.

### Preventing Corrosion

Cor-ten is corrosion resistant, not corrosion proof. It's still important to take precautions against corrosion. Here are some general tips:

The chance of corrosion is impacted by the environment. Seaside properties will suffer the most from corrosion. Be prepared for a regular monitoring and maintenance cycle if you live in a corrosive environment.

- Avoid creating water or dirt traps and crevices.
- Rust stains may run to adjacent surfaces and cause staining
- Fasteners should be made of weathering steel
- Specific low alloy welding rods should be used
- For an even weathering result, surface blasting may be necessary
- Weathering steels are unsuitable for use in marine and aggressive industrial environments

**Welding Tips**

"If its less than 10 mm thick and the weld is a single pass (a fillet) you can weld it with mild steel. If its MIG ER70s-6 *SG2* G3Si1. You will get enough dilution from the plate to weatherise the weld.

If it's over 10 mm or if its multi-pass you need either a similar composition (nominally 1%Ni 0.5%Cu) usually classified as ER80S-G or ER80S-W alternatively you can use a 2.5% Nickel steel ER80S-Ni2

Cor-ten "A" is a weathering steel that has a higher than normal copper content, this forms a rust preventative oxide on the surface that prevents "weathering" you can get a specific wire for cor-ten but the general consensus is to treat it like s355 type material."

Source: http://www.residentialshippingcontainerprimer.com/

**Wetting-drying cycle**

To weather in the desired, controlled way, weathering steel needs to be exposed to a wetting-drying cycle. This wetting-drying cycle forms the protective oxide layer. The wetting cycle causes the corrosion, while the drying cycle allows the oxide layer to become nonporous. Therefore it's important to carefully consider the detailing of crevices, channels and roofs to ensure that this cycle can occur.

The container should never be constantly exposed to moisture. Dirt, dropped leaves and moss buildup or pooling water is deadly to weathering steel, so consider siting and design carefully to ensure the longevity of your home.

## Coatings

It is possible to paint weather-resistant steel. You can use a regular paint suitable normal grades of steel. Painting your container can be a real benefit. It will protect the weathering steel and damage to the paint does not result in under-creep corrosion to the surrounding painted area.

When covering weathering steel it's important to avoid anything that will retain moisture. Nonporous materials are much better. Glass, stainless steel, glazed bricks and tiles, washable organic coatings and paints, aluminium (anodised or non-anodised), polycarbonates and neoprene work well.

## Galvanic Corrosion

When certain dissimilar metals come into contact, moisture can cause what's known as galvanic corrosion. Weathering steel can be affected by galvanic corrosion. If dissimilar metals are to be placed in proximity to weathering steel, then good detailing practice should ensure the elimination of traps for water and/or the separation of the metal, with an inert material.

This also applies to the fixing methods you use. Avoid using zinc or cadmium plated bolts. Specify weathering steel or stainless steel nuts and bolts instead. Galvanized nuts and bolts should be separated from the surface of the weathering steel using rubber washers. Welding isn't a problem so long as you follow the welding tips. When purchasing welding materials, mention that you're working with weathering steel and the supplier will be able to provide consumables suitable for this purpose.

## Other Points to Consider

Despite spending much of its life riding through salt spray, exposure to salt affects the patina of weathering steel used in shipping containers, causing it to lose its nonporous state. For this reason, if you're building within 2 km of the coast, you should avoid using unprotected weathering steel.

Concrete, stone and unglazed brick may suffer from oxide staining when in contact with weathering steel. So consider where the 'drip line' of you container is if this type of stain would upset you. Put a nice garden there instead!

# Insulation

## Making a comfortable home from your steel box

Insulate, insulate, insulate. Unless you like the idea of sweating through summer and shivering through winter, you'll have to modify the container to ensure it's livable in your climate. Without insulation the container is a huge conductor of heat, making it impossible to keep warm in winter and causing it to become a virtual sauna in summer.

Apart from your own comfort, many authorities require new buildings to achieve a certain level of thermal efficiency. Or they may even dictate a required 'R-value' for your home. R-value refers to the efficiency of your building envelope to resist the flow of heat. All insulation comes with an R-value, but to obtain your home's overall R-value, you need to add together the values of each building component. For walls for example, you might have plaster, polyester batts, sisalation, an air gap and the steel of the container coated with insulating paint. The R-value of each of these needs to be added together to find the wall's R-value.

This is not as complicated as it sounds, but to properly assess the thermal efficiency of your design, it's best to get an energy assessment done by a professional. You can include this assessment as part of your building permit to demonstrate your design is up to code.

### Where Does the Insulation Go?

To make space for insulation, you'll need to build out either the internal or external walls of your container. In theory you can use any insulation you like, but a few types of insulation are most commonly used (and easily applied) to shipping container homes. When choosing what type of insulation to use, weigh up the products' efficiency (calculated as an 'R-value'), cost, application techniques, and environmental impact. You should also think about durability. Here are the most common types of insulation that can be used in a shipping container home.

### Batts

By packing out the walls of your shipping container with either timber or steel framing, you create a sufficient depth to install batt insulation, which is generally the cheapest and most easily sourced type of insulation. Batts can be easily installed without much technical knowledge, just make sure you achieve even coverage and fill all the gaps. Look for the types with the highest R-value to achieve the best level of insulation. An important consideration with batts is that they are installed correctly. Sloppy installation can reduce the whole home's thermal performance. With batts, the R-value can also decrease over time as the batts lose their fluffiness, sag and deteriorate.

**Loose-Fill Spray**

Another alternative is loose-fill spray. Loose-fill spray can use either traditional insulation materials like polyester or fibreglass combined with low-toxicity binders. More environmental materials like recycled paper or wool can also be used. Generally these types of fibrous insulations are designed to be sprayed into a cavity, so you will need to pack out the container with stud walls before spraying the insulation in place. Other types are designed adhere to joists and can be sprayed directly onto the container wall. Loose-fill spray relies on correct installation and it's important to ensure careful management of moisture content and density of the insulation. For this reason, it's best left to professional installers.

**Spray Foam**

Spray foam is a popular option for insulating shipping container homes. In the past these products used high-density, closed-cell polyurethanes with the added risk of exposure to hazardous chemicals. These days, the products release their VOCs (volatile organic compounds) quickly and are safe after a short time. One drawback is that most products still use HCFCs as blowing agents. That's the stuff that puts a hole in the ozone layer! But more and more products are turning HCFC free, so do your research. Spray foam can be purchased in DIY kits and installed yourself.

**Structural Insulated Panels**

An alternative to traditional insulation, Structural Insulated Panels (SIPs) are a sandwich made from Oriented Strand Board (OSB) with a foam core. These

present a good option for shipping container homes as no framing or battening is needed. That said, fixing and assembly can be a challenge, so you're best to consult an expert for installation.

**Framing Details**

In shipping container homes, it's important to consider framing's effect on insulation. Framing creates a thermal bridge effect which can reduce the effectiveness of the insulation you install. While steel framing is often easier in shipping container homes, remember that steel studs will lose more heat than timber studs, so it's important to insulate between the steel frame to prevent this thermal bridging.

**More Info**

In the resources I've included a great article written by Fernando Pages Ruiz which outlines and reviews virtually every insulation product.

# Windows and Doors

## Letting the Light In...

You're obviously going to want to add windows and doors to your shipping container. We discussed the concerns of significantly altering the structure of the container, but as a general rule of thumb, inserting standard size windows and doors shouldn't be a problem. I'm certainly not encouraging you take the easy route and give up your plan of floor to ceiling glass in the long end of your 40' container, but it's something to bear in mind!

There are many ways to create openings for new doors and windows, but one of the most popular (and successful) methods involves using square or rectangular hollow section as the frame and fully welding that to the container. This fully seals the opening to prevent water and air infiltration and allows for the corrugations of the container.

Plus, using steel hollow section makes the frame structurally strong and tends to counteract the problems caused by compromising the structural integrity of the container. Don't just take my word for it though! You should, of course, consult your engineer.

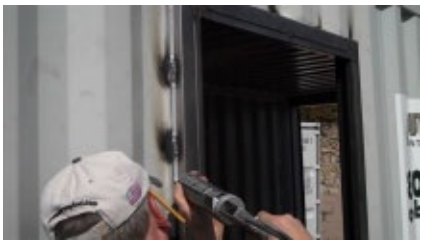


Image Source

# Roofing

## Put a Lid On It

It's essential to provide an additional roof over your shipping container home. The container itself has a roof, of course, but it wasn't designed to act as permanent roof for a domestic home. It's just a thin sheet of steel with ridges and a slight camber to encourage water run off. In fact, a shipping container roof only needs to support the weight of one man - they're usually pretty thin and flimsy!

In a domestic setting, you'll require space for insulation, a more efficient method of collecting and diverting storm water (either to a drain or a water tank). A separate roof also helps to prevent solar heat gain to keep your container home cooler in summer.

The type of roof you chose will come down to the plan and layout of your shipping container home, your climatic conditions and, of course, your personal preferences. My advice for designing a roof for your shipping container home is to keep is simple. This will save money and construction time!

### Hip

A standard, rectangular planned hip roof has four faces which are usually the same angle. A hip roof is particularly suited to high wind areas.

### Gable

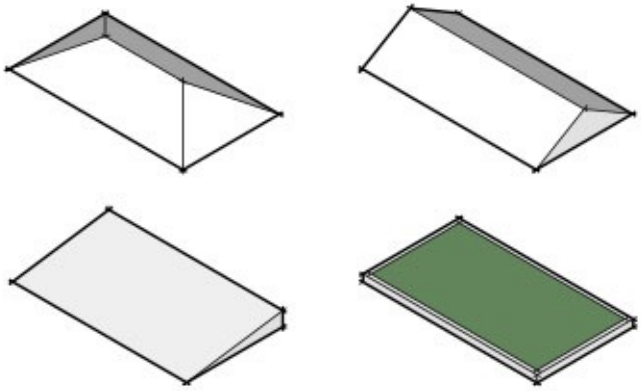
Like a hip roof, but with vertical end. Can be useful in snowy areas.

### Skillion

Skillion roofs have a low, modern profile which can work especially well for shipping container homes. Using a deep trough roofing material you can achieve very shallow slopes - 1 or 2 degrees, which can easily be concealed behind a steel parapet for a very slim line look. This type of roof is only suitable in areas with moderate to low rainfall and can be susceptible to leaking.

## Green Roof

Green roofs are an increasingly popular option these days. They provide excellent thermal efficiency - helping to moderate the temperature inside the home, encourage wildlife and reduce water runoff. Plus, they look all lush and green! For brown thumbs or urban areas, consider a brown roof instead (it's a thing).



**Roof types (clockwise from top left):** hip, gable, skillion (flat), green.

# Case Study #1

## Port-a-Bach, New Zealand

**Photographer:** Paul McCredie

Architects Atelier Workshop have designed a tiny home from a 20 foot used shipping container that serves as the perfect weekend getaway for a family of four. This one was fitted out in Hangzhou, China and shipped to New Zealand. It is a shipping container, after all - it's inherently portable! That's why it's been dubbed the Port-a-Bach ('Bach' is a New Zealand term for a small holiday shack).

While there's not a lot of space inside, the original long wall folds down to become a deck and make the most of indoor/outdoor living. This openness helps the space feel larger. Between the fold down bunk beds and the pull down double bed, it can comfortably sleep a family of four.

The Port-a-Bach fits a lot into a tiny space:

The Port-a-Bach fits a lot into a tiny space.

- Fully enclosed exterior steel shell (when folded up).
- Large internal storage cupboards and shelves, stainless steel kitchen and fittings, bathroom with open shower, sink, composting toilet.
- Interior fabric screen system gives the versatility of creating several 'rooms' within the large open living space - bunk beds, double bed room, dressing room, kitchen and bathroom.
- Exterior canvas screen system shelters the deck area for comfortable indoor/outdoor living and flow.
- Six concrete footings form a stable, noninvasive 'foundation' - situate the unit on a wide range of ground conditions.

The Port-a-Bach's inherent portability opens up a number of possibilities. It is well-suited for situations where a permanent structure is not allowed for safety or environmental reasons, like another NZ Bach which is relocatable thanks to built in sleds. It might also suit a worldly nomad - allowing their home to be shipped wherever in the world they're off to next.

The Port-a-Bach can be delivered quickly and easily to almost any site via truck or helicopter.

Another important part of the Port-a-Bach's appeal is the ability to lock it down when not in use. Once the drop down deck and the side doors are closed the home becomes a solid steel shipping container again. This makes it perfect for second homes where security or safety from the elements is a risk. Bush or forest fire-prone areas are just one potential application. The Port-a-Bach's prefabrication of internal finishes allows for a high level of quality. Off-site fabrication offers other benefits as well. The building can be subjected to more thorough quality control and assurance. It's faster too, because tradespeople are in-factory and there's no reliance on fine weather. The internal finishes are primarily plywood, which is a quality, hard-wearing material for long-term durability.

Due to the Port-a-Bach's portability, it might also be possible to beg/borrow/steal land rather than purchasing it, which would further reduce up-front costs.

It's possible to make a home like the Port-a-Bach completely self-sufficient - perfect for sustainable, off-grid living. It could be power, water and sewer independent by installing a rainwater tank, composting toilet or septic system and solar panels and/or a wind turbine. And that means no more costly bills from

and solar panels and/or a wind turbine. And that means no more costly bills from utility companies...

Port-a-Bach is an enticing solution for a low-cost, low-maintenance weekend retreat. Minimal modification to the standard shipping container keeps the costs down, while an innovative design ensures it's a very usable and multifunctional space - in spite of the tiny footprint. Really, what more do you need for a low-fuss weekend getaway?

**Photographer:** Paul McCredie

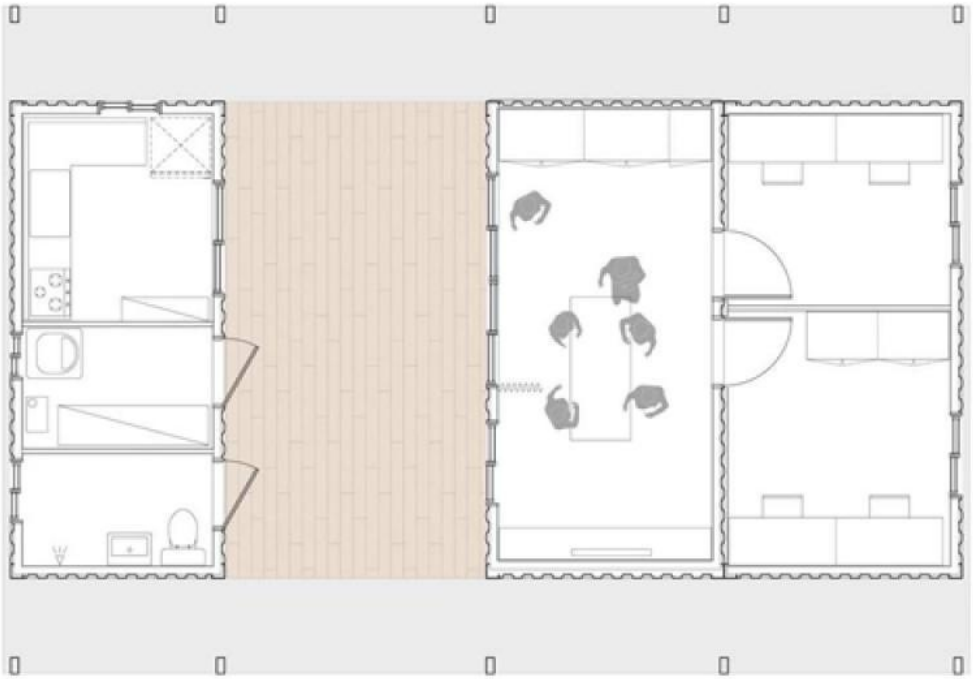
# Case Study #2

## Low cost Family Container Home in South Korea

**Photographer:** Hwang Hyochel

The Korea Child Fund has sponsored its second "Low Cost House Series" project in an effort to improve the living environment of families with low-incomes. This family got a new house and the builders managed to save some serious Won. They created a modern and bright container home using just three 20' shipping containers. A translucent skin provides extra space at a rock-bottom price.

Designed by JYA-RCHITECTS in the small village of Jangheung town in the southeastern province of South Korea, this Low Cost House provides shelter for a family of seven. The architects used shipping containers and light gauge framing to offer an inspiring example of how green design can overcome even the tight budget.



The design and construction team examined the conditions of the family's existing home and found that the physical and environmental conditions were too poor to renovate. Therefore, they decided to knock down the home and rebuild it.

The team then evaluated the huge budget issue and decided that multiple cost-cutting measures could be implemented through innovative building methods.

First, they chose to build a 'container house' that minimizes site work and construction time. Their second design innovation included surrounding the 'container house' with a light gauge structure to provide an insulating layer and outer living space surrounding the interior rooms.

This "Low Cost House" gives new meaning to sustainable and social responsibility in design. JYA-RCHITECTS, the construction team of Ra Kwonsu, and the Korea Child Fund have worked together to offer a better life for another family in South Korea. The team offered a sustainable option to bridge the economic gap of the construction cost, and proved that sustainability

bridge the economic gap of the construction cost, and proved that sustainability can be affordable.

**Photographer:** Hwang Hyochel

# Case Study #3

## Shipping Container Guest house, Portugal

**Photographer:** Studioarte Architecture

The guest house by Studioarte Architecture uses one 40' shipping container, but achieves a sense of spaciousness thanks to an attached outdoor room. The interior and the outdoor room, surrounded by curtains and covered by a shade sail, are connected by a large sliding glass door.

Inside, the shipping container is divided into just two spaces to make it feel as large as possible. A bathroom area is separated from a living/dining/sleeping room. There is no kitchen as this guest house is auxiliary to the main house. And of course there's always the outdoor BBQ!

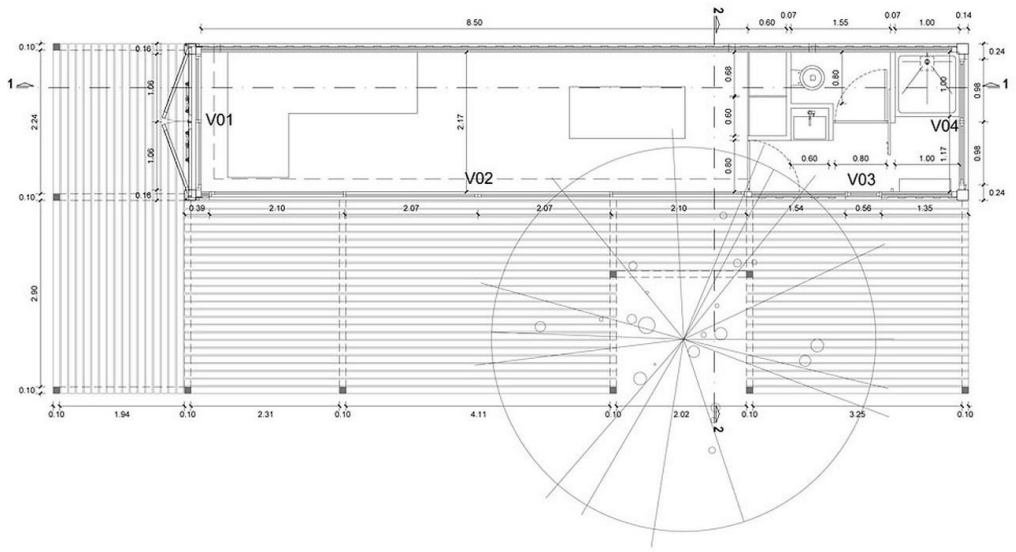
The interior is creatively decorated with a large mural along the shipping container's long wall. This makes the space feel light and energetic.

**Photographer:** Studioarte Architecture

The shipping container's interior walls have been thoroughly insulated to provide thermal protection. Even though Portugal has a mild climate, no one wants to live in a steel box! Outside, the original corrugations of the shipping container are left exposed.

A separate roof sails over the shipping container guest house. This is a great solution for Portugal's climate, helping to shade the container from the brunt of the European sun. This affordable shipping container guest house has been cleverly designed to maximize the sense of space on a shoestring budget. A minimal floor area is supplemented by a generous outdoor room. This project is a great example of the benefits of using a shipping container as a building block for a simple and affordable guest house, granny flat or studio.

**Photographer:** Studioarte Architecture




PLANTA PISO 0

ESCALA 1/50

studio arte VALE DA VILA
ARCHITECTURE & PROJECT MANAGEMENT
ARQ. ARNOLD AARSSEN
ARQ. JOSÉ PEDRO BRAZ
arnold.aarssen@studioarte.info www.studioarte.info

# What Next

Didn't Find What You're Looking For? Missing Something? Still Have Questions?

This is a beginner's guide. Obviously how to design and build a Shipping Container Home is a huge topic. To complicate matters further, regulations, technology and techniques are constantly changing.

So, if you're curious about something in particular, know of other ways to tackle a shipping container project, or still have a nagging question, don't be afraid to let me know.

So, shoot through an email at hello@lunchboxarchitect.com

Oh, and if your shipping container home dream gets off the ground, be sure to let me know!

# Resources

Guess What?

A constantly updated page of resources and shipping container home information can be found here.