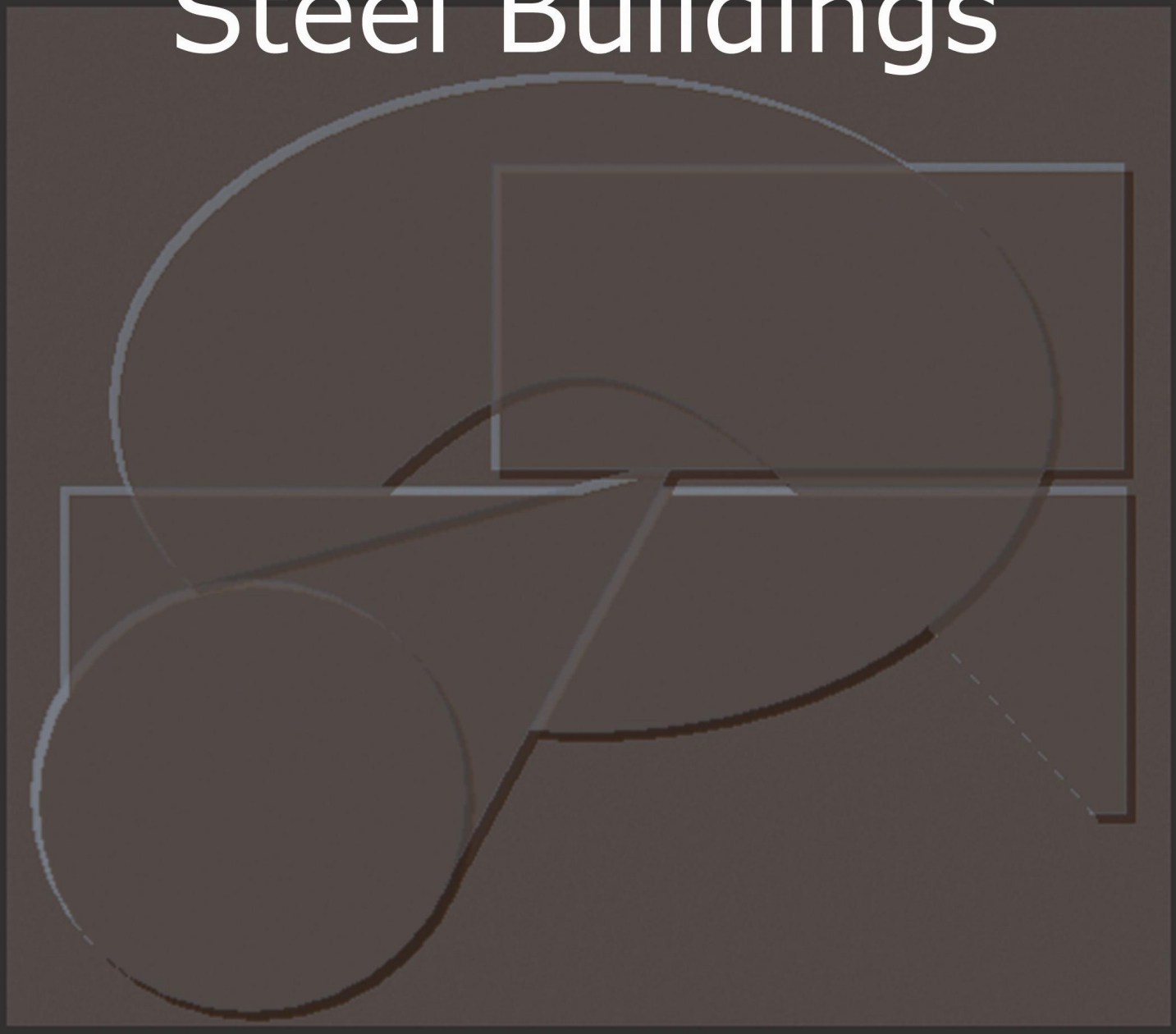
Intermodal Shipping Containers for use as Steel Buildings



Second Edition

By Paul Sawyers

Intermodal Shipping Containers for use as Steel Buildings

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Written & Illustrated by Paul Sawyers
Photography by Samantha Rose

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About The Format of this Book

This book is currently not available in a traditional printed version. The reason for this that the production costs for printed books is somewhat prohibitive in short run situations. So until I am able to fund a large run of printed paper books, the digital PDF format will have to do.

The PDF method eliminates most publishing expenses and allows me to price the book far lower than a printed version. You can print the book at home on your computer, and even put it in a binder if you feel so inclined.

PDF has become a popular format for distribution of documents over the past 10 years. Most educational institutions, local, state, and federal governments all utilize PDF for forms, manuals, and documents.

Feel free to contact me via email if you have any questions about this book, or just want to say hello. My address is paulsaw03@yahoo.com

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Introduction

This book is about building small steel structures using Intermodal Shipping Containers. Most of the designs included can be built by the average weekend builder.

Intermodal Transport became a passing interest for me after moving to the west coast in 2002. This was probably due to the close proximity of a major container port and frequent spans of driving behind container trucks on I5. Boredom behind the wheel, and miles of looking at the back end of containers began to inspire interest in these seemingly super strong boxes. It didn't take long for me to realize that a small building could be assembled easily using these boxes.

I remember watching the 1980's science fiction movie 'Space Rage: Breakout on Prison Planet' and getting my first glimpse of container buildings. About halfway through this B flick, I marveled a extensive set build entirely from 20, and 40 foot shipping containers. The movies plot was a wild-west-space-age shoot-em-up, and utilized a futuristic old west town made from containers.

Since those first sightings of container buildings, I seemed to have developed an addiction to gathering information about these buildings. I'm always on the lookout for a container building when I traverse the countryside. As a result, I have been able to document the many uses and structural variations people come up with. You can label me as a true believer in these small steel structures.

With the advent of more severe natural disasters each year, global society requires a new low cost building design that can withstand tropical storms, earthquakes, and tornados. I truly believe that these type of structures can provide this. A low cost building solution to more and more people worldwide as we press forward into the next century.

This book covers some of the container building designs I've seen, and some I've come up with myself. To my knowledge it is the worlds first book on the subject. I should stress that this subject is not new, and many sharp minded individuals around the globe have designed, and built more advanced container buildings than I could even attempt to illustrate. I would also like to give credit to the designers and builders who devised the original concepts of these structures. Their names are not known to me (although I did search the internet in hopes of finding information), but they are the true innovators. I can only assume that these buildings date back to the 70's and 80's, and a few original thinkers in the freight shipping industry.

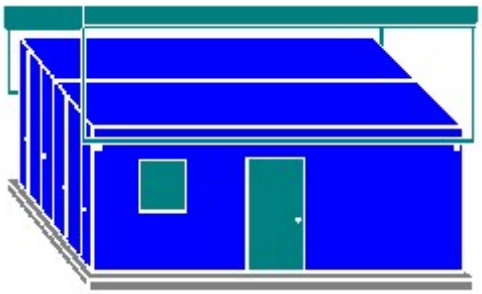
Container Ship

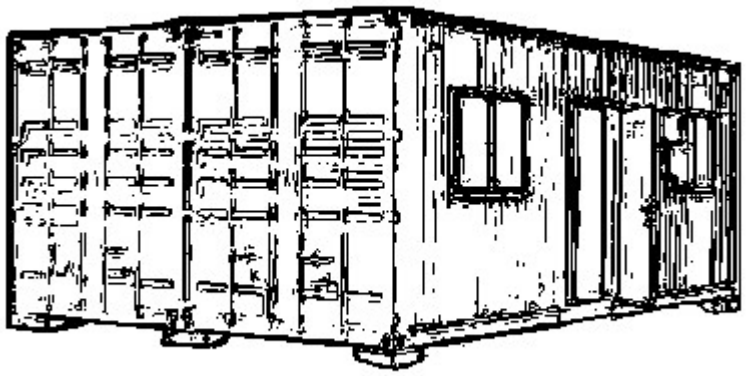
A fair amount of research on the subject of international trade, and shipping was done in preparation for this the second edition. One important factor effecting us all is the major increase of Chinese made goods imported into the North American market, all via Intermodal.

I was able to stand along The 'Hook' in the City of Port Angeles, WA (where I lived in 2004), and watch east bound container boats (toward Seattle) in the Straight of Juan De Fuca all day long. Most of these containers are packed full of items from China, a country that has become the worlds number one manufacturer of stuff. Like it or not, the North American economy has changed, moving away from manufacturing. Many jobs have also been outsourced to foreign workers. All the more reason not to break the bank when you build.

Research also points to the rapid production and deployment of more TEU's (20 ft containers) than ever before. Use of all other modes of shipping goods has decreased since the mid 90's, while Intermodal use has skyrocketed. These trends will continue. This will prove to be a good thing for the budget Intermodal builder, as larger supplies of surplus containers emerge, savings increase, and deals for the small quantity buyer begin.

I would like to thank the buyers of the first edition, many of whom provided valuable technical feedback and interaction with me on the subject. With the addition of CAD designs in full color, I hope to provide a more useful resource to readers of this publication. Special thanks to my brother (who is a CAD designer for the automotive parts industry in Detroit), for his advice and guidance on my CAD designs. Also special thanks to Samantha for her photos of containers and ships here on the Olympic Peninsula of Washington State. Additional credits can be found at the end of the book.
Thank you and enjoy!



	*As a person who resides in the Pacific Northwest of the United States, I can observe the timber industry then ask "why does wood cost so much". Harvestable wood seems to be endless around here! Building with lumber is always a pleasure, but the ridiculously high cost these days is too much. Just try driving a truck load of lumber out the parking lot of your local home improvement superstore without feeling several hundred, if not thousand dollars lighter. It's probably not going to happen.*

About Containers and Container Buildings

Taxes, restrictions, and a ban on Canadian softwood imports have caused lumber prices to jump up and sock the weekend builder in the eye. The devastating hurricane season of 2004 has created an unexpected demand for lumber, raising prices and reducing supply even more. To hope that lumber will once again become affordable is wishful thinking. The free-for-all that was the Lower 48 States pool of natural resources (last century), not surprisingly, has ended. Even mainstream builders have begun to use alternative structural products. The most obvious examples of this trend; OSB (chip board sheathing) in place of plywood, and OSB engineered joists.

If planning a small do-it-yourself building project, I propose the reader consider using a heavy duty welded steel box with 1.5 inch marine grade hardwood flooring. A pre-made, and ready to go small building that is very strong, able to support ten times its weight. The ISO Intermodal Shipping Container.

Ocean going cargo is shipped in steel boxes called Intermodal containers. The freight industry refers to these as TEU's. One 20 ft container equals one TEU. One 40 ft container equals two TEU's. Volume of TEU imports and exports are the factors that display consumption, and create prosperity in nations. These cargo boxes are built to strict international quality standards, to survive harsh treatment and a violent life in the marine environment. These steel boxes are also known as cargo containers, containers, sea boxes, or ISO containers (International Organization for Standardization).

This book will provide an assortment of various building designs made from these containers. Some of these are designs I've seen here on the (Olympic) Peninsula, and many are my own creations. Most of you will have your own ideas for designs too. I have attempted to include all the necessary info to obtain your container, customize it, and wrangle it around your little chunk of the earth.

The term Intermodal refers to the units ability to be loaded on ships, trains, or tractor trailers with it's integrated stackable chassis. Container cranes (usually, a rail-mounted gantry crane located on a wharf for the purpose of loading and unloading containers on vessels) pluck containers from train cars, or trucks, and stack them on freighters. Thousands of dock workers, once a major work force, have been replaced by the lone crane operator.

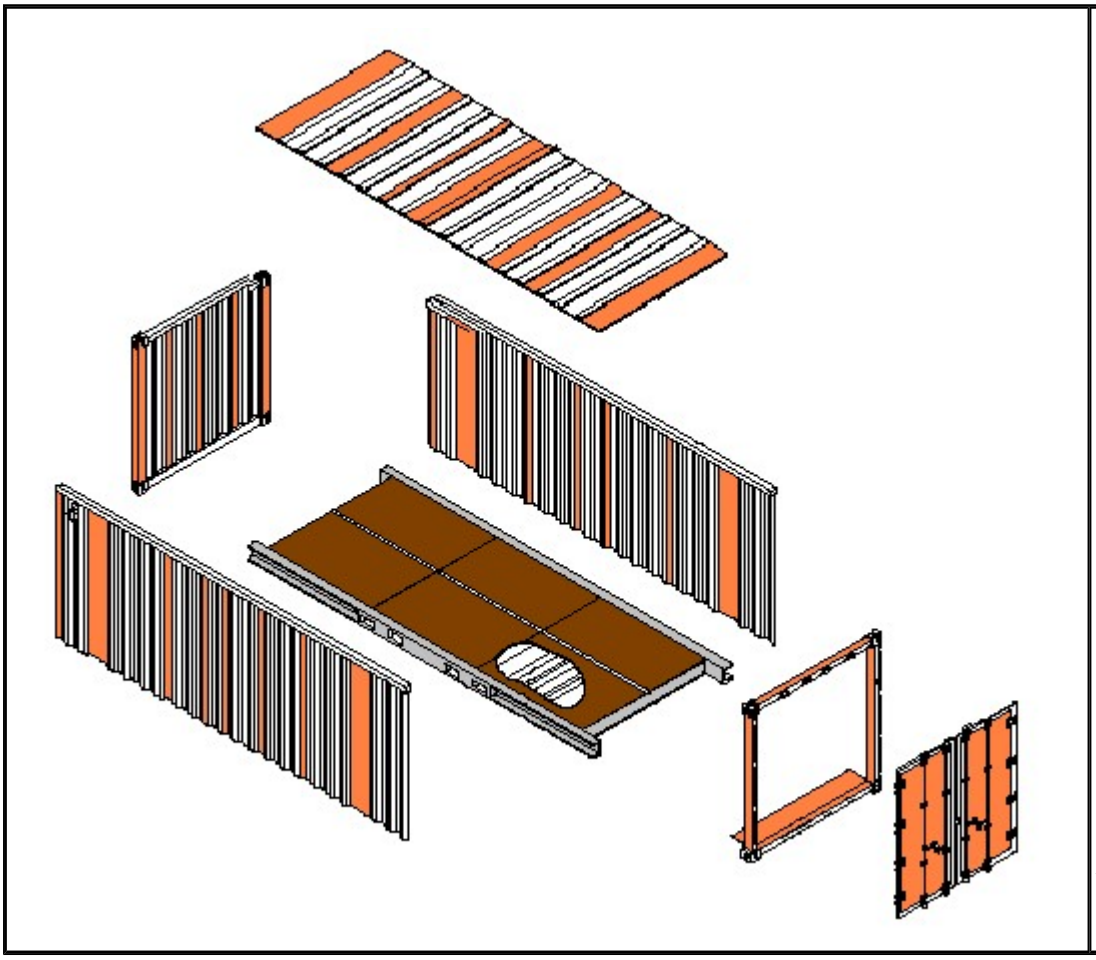
The advent of containerization has provided a major revolution in the cargo handling industry. Like many inventions we enjoy today, containers evolved during WWII, when cargo was still being hand loaded. Prior to containerization, cargo was literally manhandled. Cranes with slings unloaded crates onto pallets. Longshoremen then muscled the crates into place, and forklifts moved the pallets to warehouses. Damage and delays were common.

Improvised containers were first used by the U.S. government during WWII. Instead of shipping commodities in bulk, army and navy specialists began to mix cargo by loading freight onto pallets, then loading the pallets into specially constructed boxes. Nearly five decades later, the majority of dry cargo moves in containers. And customers around the world are reaping the benefits of a ground-breaking advance that started with a concept as simple as a steel box.

As you read on you will notice a heavy emphasis on rural placement of container buildings, less time devoted to container buildings within established city limits. This is due to the obvious problem of zoning.
Let us assume that your container building will be located on private land away from the eyes of code enforcement or zoning officials, if any. If these buildings were to fall under any zoning or building category, the closest thing would probably be prefabricated structures. With that said, I should note here that many of the container buildings I have studied were located in commercial areas of the city. Rural zoning is best for personal usage, but if you have commercial property within a city, you could most likely setup a container building without issue.

If you encounter a zoning roadblock while erecting a container building, I would advise you to use the position that, in general, containers are portable structures, and do not fall within the permanent building city codes. A container building is no different than the 39 ft RV, your neighbor has parked out back. Of course, you can always apply for a building permit before you build, and if your situation is such that you must, then by all means do. You may find some of the documents presented in this book helpful if you include them in your building plan when you apply.

The containers covered in this book are steel built, 8’ wide externally, 8' or 8’6” tall externally, and available in standard lengths of 20’ and 40’. After taking into account the thickness a basic 2x2 framework (if you choose to use interior frames) and minimum of insulation material, the remaining rough interior dimensions the container builder has to work with are: width of 7.5', and height of 7.5'. There are many other types and sizes of containers on the market, but I wanted to design with the two most common sizes of dry cargo units for sake of simplicity. The 20' standard unit, and the 40' standard unit. The 8ft high and 8.5ft high models appear for sale most commonly, and at about the same frequency, and can be substituted
for each other in my plans.



Exploded View

Tops and sides of these containers are made from welded 14 gauge (.075") corrugated steel, on a 7 gauge (.18") tubular steel frame.

Corner fittings are made from solid blocks of milled or cast steel and welded directly to the frame on each of the eight corners.

One and a half inch thick marine grade plywood floors adds rigid ness and a smooth surface for the units inner deck.

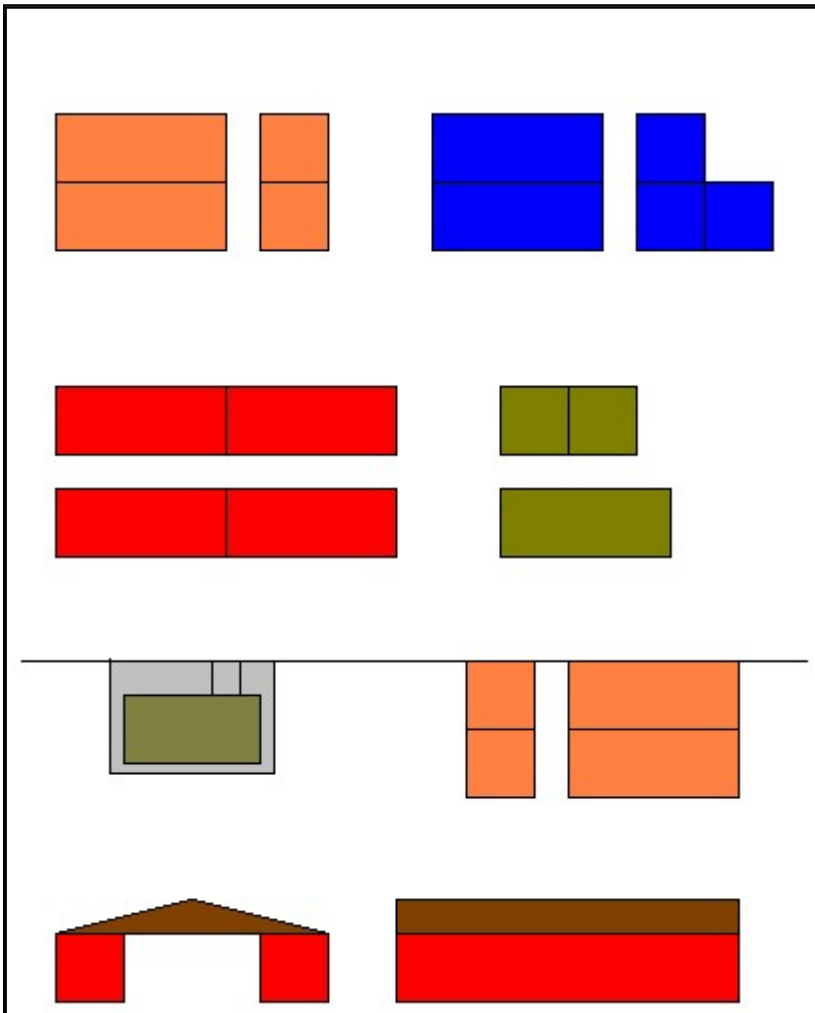
All weather paint is standard on the exterior and interior.

Let's examine the current cost of lumber verses using containers. You can buy a near-new used 40' container and have it delivered for about $1450. 20 ft units come in for even less ($800 for a good used 20 ft). The cost to build a 400 sq ft shed from lumber purchased new averages out to be at least $2450.

Here's how lumber prices, and availability hypothetically effected construction plans for a 1000 sq ft garage in the autumn of 2003: The price of sheathing material (plywood and the wood-composite product oriented strand board (or OSB) went up. OSB sheathing prices reached $445-$535 per 1000 sq ft on 9/12/2003, depending on grade and thickness. The price per 1000 sq ft of OSB sheathing on 8/22/2003 was only $374. That's a big increase in less than 30 days.

A typical 1000 sq ft garage consumes 3000 square feet of structural paneling. In 2002 the structural-paneling composite price was at $240 per 1000 sq ft, while OSB was $139 per 1000 sq ft. Just going with the composite price, the 3000 sq ft that cost $1440 in September 2002 was at $3210 in September 2003, about 2-1/4 times more expensive. Every 1000 sq ft structure needs 8000 board-feet of framing lumber such as 2-by-4s and 2-by-6s. In September 2002, 8000 board-feet, at $288 per thousand, cost $2304. In September 2003, it was $382 per thousand board-feet, or $3056. So, the total cost of
all lumber required for a 1000 sq ft structure rose from $3024 to $4660 in just one year.

If you build a doublewide container building consisting of (2) 40 ft units, you can have a 640 sq ft building for about $3000. You instantly save at least $1500, while enjoying a structure that's perhaps 50x stronger than wood. The loss of square footage as compared to the lumber built structure is minor. Of course, if you find your containers for sale cheaper, even more savings can be had.



Common Layouts

Placement of 20 or 40 ft containers side-by-side in a permanent building form, will create the most useful space, but even a single 20ft x 8ft container makes a nice little workshop or utility building.

As I will cover later in the book, you will see that foundations are not necessarily required, but you should use some type of footings. Slabs make a great foundation for container buildings.

A 40ft x 16ft (2- 40 ft units) building, resting on a 6 inch slab of concrete, and topped off with a lumber built truss roof and shingles, makes a beautiful and useful structure for a third of the cost of a factory steel building, even after paying for a cement company to lay the slab.

The simplicity of construction speeds the building process considerably. If you know you can construct a building, but become overwhelmed with all the details, materials, sources, time frame, etc, container building might help. The lack of materials required can ease one's mind considerably. You really only need one or two containers, and a foundation.

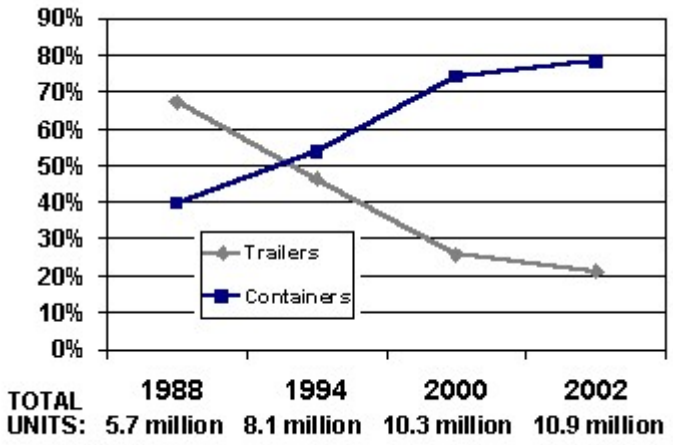
If you want, additional structural aspects can be added when you have the time and money. Add a wood roof, wiring, extra doors and windows, even interior walls. One days worth of coordinating and stress can be expected, and that is on delivery day, as you will be dealing with the trucks, and perhaps a crane or excavator rental (if needed).

Factory made steel buildings are available for purchase. This industry has grown considerably since the 1990's, due to the high cost of lumber. When you buy a steel building, you get a quality product, but prices for these can be out of reach for some of us. Remember, when you buy a new steel building, you're paying for the design, marketing, warehousing, and other overhead. Container buildings can look just as good, are stronger, and don't have all the built-in overhead to increase cost. If you had the money to buy a new steel building, and wanted such, I wouldn't try to talk you out of it. I would wonder though, why you didn't want to try something new, and save several thousand dollars in the process.

Containers could be used in conjunction with a factory steel, or lumber built structure, as a dormer, extra room, or extension of the building. If for example, part of your building was damaged or missing, a wall perhaps, a container installed on that section could do a nice job of repair. If you must build a traditional lumber structure, a container could be used as temporary housing and secure tool storage on site, then permanently installed as a workshop.

The possibilities are really quite endless with these boxes. What's really exciting, is the rapid increase in use of these units in shipping. There more and more containers being retired on the east and west coast each week.

Those of you that reside near the I5 or I95 corridors can find good deals on used units, and with the propagation of containers, these deals are spreading inland. Container manufacturing has become a major industry unto itself that provides jobs and supports families.



Containers are retired for numerous reasons, but damage beyond use is not usually one. These factors equal a surplus of low cost containers for sale, and for us the low cost builder, a promising outlook for more of the same in the coming decades.

Purchase and Delivery of Containers

Regional classified papers such as trader publications, and little nickel press are good sources for buying containers. Titles of these newspapers vary from state to state, but most of you know about the types of publications to which I am referring. The classified papers with just stuff for sale advertised.
You can also look through the phone book under "shipping", "containerized freight", "mobile storage", "shipping containers" or "freight shipping" for local sales outlets.

I had originally considered listing the many websites that advertise containers and related products, but more often than not, a website possesses a 'here today - gone tomorrow' quality. Although, I have noticed an increasing number of containers being offered for sale on the big auction websites.

Besides these auction websites, you can search google.com for current container wholesalers. I found several 20 ft units in nice shape offered for $800 while surfing the web. Below are a few techniques to help you find current websites fast and efficiently.

The art of searching and finding what you are looking for on google involves the use of characters to connect keywords. This prevents the search engine from returning a shotgun pattern of unrelated websites.

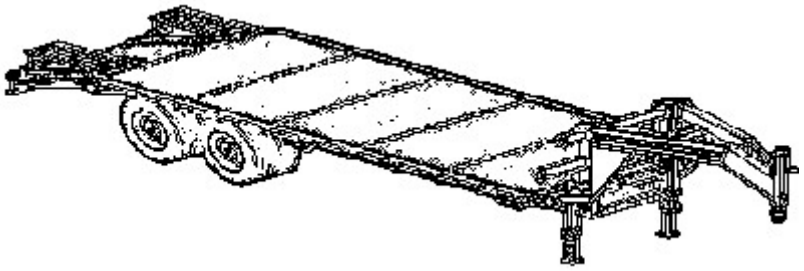
type: shipping>containers
not: shipping containers
type: shipping>containers>for>sale
not: shipping containers for sale

Containers are by their very nature, mobile, but designed mainly for sea travel. Yet, thanks to the increasing number of transport companies, units are now available just about anywhere in North America. Many of these companies offer delivery with a roll-bed truck similar to the type that picks up full size construction dumpsters. Delivery is offered with or without dropping the container to the ground, and is based on a per mile fee. Drop delivery operations require fair road access (gravel or dirt is ok), and a 75' cleared area.

For the container purchaser who only requires the unit delivered to a firm surface, at the end of a easily accessible road (for a delivery truck), the process will be easy.

On the other hand, if your destination is more off-the-beaten-track, logistical problems can arise. The seller will ask about this when you buy your unit's). Most companies will drop the unit as close as possible to the area you want, and let you wrangle it from there. The seller will discuss logistics with you before actual delivery.

Take care not be overcharged for delivery, or jump at a great deal on a container, and be hit with a high delivery fee. Expect to pay a dollar +/- per mile for delivery. If you find a superior deal on delivery fees, it is possible to purchase a container from one source, and have another trucking company pick it up. You can also tow a 20 ft container yourself with a 3/4 ton pickup truck and a flat bed trailer of adequate size. Attempting to move 40ft containers yourself is not advised.



Delivery drivers are often flexible, and may go off-road to drop your unit in the spot you desire. Of course there are limits to this. Expecting a semi truck to cross muddy fields or navigate your atv trails is wishful thinking. Many companies use specialized delivery trucks for 20' containers. These are called side-loaders and drop the container on the passenger side of the truck with miniature crane arms. These vehicles are usually able to reach a more back-woods locations than a semi towing a flat bed trailer.

In general, a 20' unit will get into more spots than the 40', but dealing with the driver, and perhaps coaxing him, is always a possibility when taking delivery. Drivers do the best they can to get the container as close as possible to the location you want.

If no arrangements for a special delivery truck have been made, you will need to hire a crane or excavator capable of lifting the container off the truck and onto your foundation, and have it waiting on site at delivery. The expense of hiring heavy equipment will be worthwhile, and still bring your structure together for a low cost. Cranes for hire may prove rare were you live, but large excavators are commonly available everywhere. A large excavator is capable of lifting 20,000 lbs 30 ft high. A medium sized back-hoe is adequate to lower a container from truck to foundation, but a larger size will be needed to hoist containers into place for 2nd level designs. You can look in the phone book under 'excavating / back hoe' services for this. Hook up chains, hooks, cables, or lifting straps to the excavators shovel for lifting. An excavator or crane is required for 2 level container buildings. For anything higher than a 2 level building, a crane is required.

Information to convey when inquiring about heavy equipment rental:

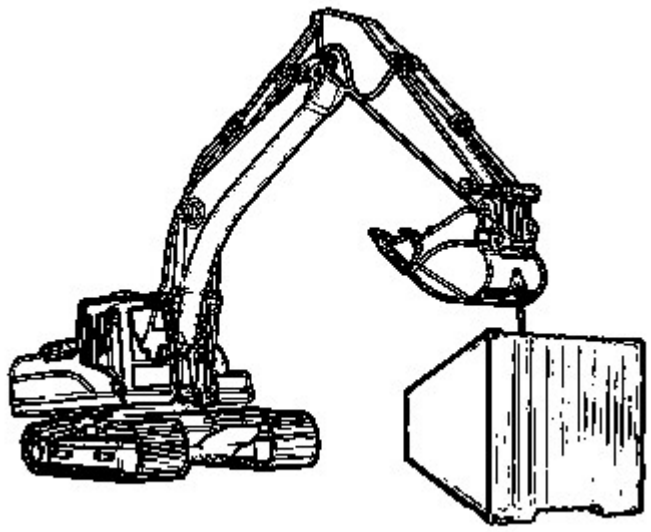
For 20 foot single level buildings: lifting of 5000 lbs approximately 12 ft to ground (4 ft truck trailer height plus container) will be required.

For 20 foot 2 level buildings: lifting of 5000 lbs approximately 12 ft to ground from trailer will be required. Then the container must be lifted another 8 ft (20 ft total) to set it in place as the 2nd level.

For 40 foot single level buildings: lifting of 8000 lbs approximately 12 ft to ground (4 ft truck trailer height plus container) will be required.

For 40 foot 2 level buildings: lifting of 8000 lbs approximately 12 ft to ground from trailer will be required. Then the container must be lifted another 8 ft (20 ft total) to set it in place as the 2nd level.

Lay pieces of scrap 2x8 lumber down on top of concrete footings to absorb any sudden impact they may encounter during placement of the container via heavy equipment. Use a auto jack to raise your container and remove these later.

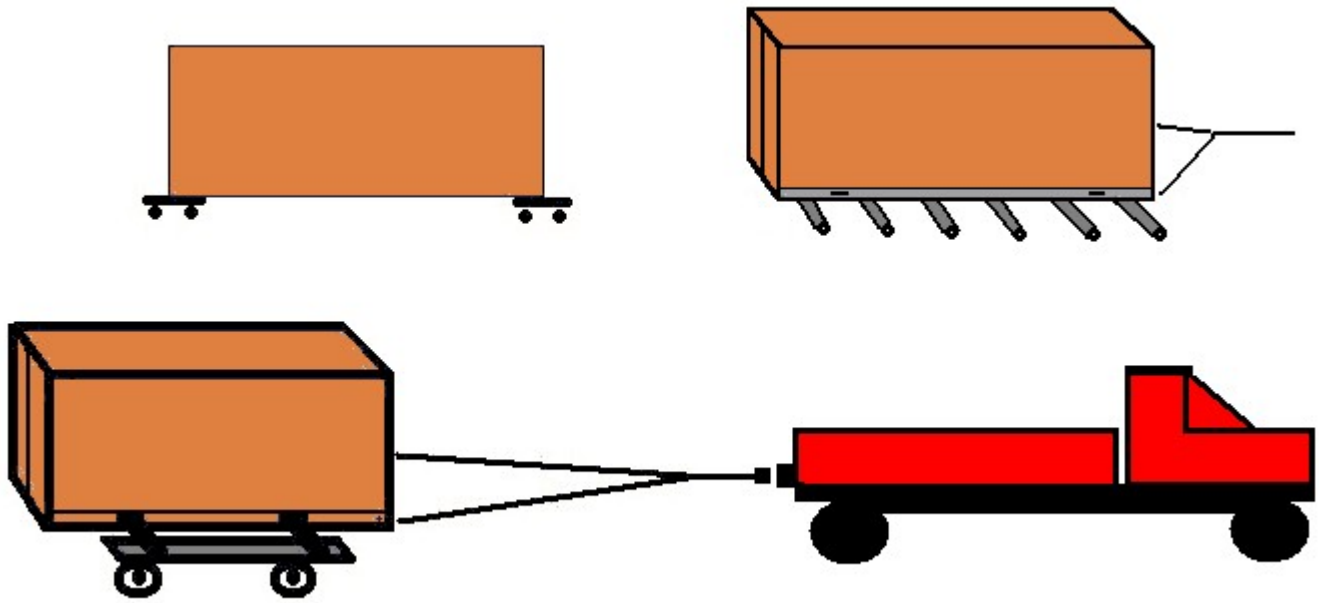


It is possible to move containers short distances yourself in no-truck-access areas. Two words to remember when planning to move a container without heavy equipment are physics and leverage. If you must move the container yourself, this task may prove the most difficult part of the project. With that said, the use of common everyday tools will be of great assistance.

Techniques and tools to assist a self mover include: winches, block and tackle set-ups, cables, hand-cranes, come-alongs, pickup trucks, large diameter steel pipes or logs (to tow containers over), large casters, home-built buggies (inserted through high-low holes), jack stands, hydraulic ram lifters, and tractor jacks.

Many of these items are available locally. Also check into Harbor Freight Tools (www.harborfreight.com), and Northern Tool (www.northerntool.com) for low cost hydraulic jacks, tractor jacks, towing gear, and ram sets.

Sometimes moving the container yourself will not be possible. What I mean by this is, examine your scenario carefully when putting together the logistics of delivery and first day construction.
Do not expect to move a 40 ft unit down the side of a mountain yourself. Placing a 20 ft unit on the back-forty of your semi level and accessible land is more realistic.



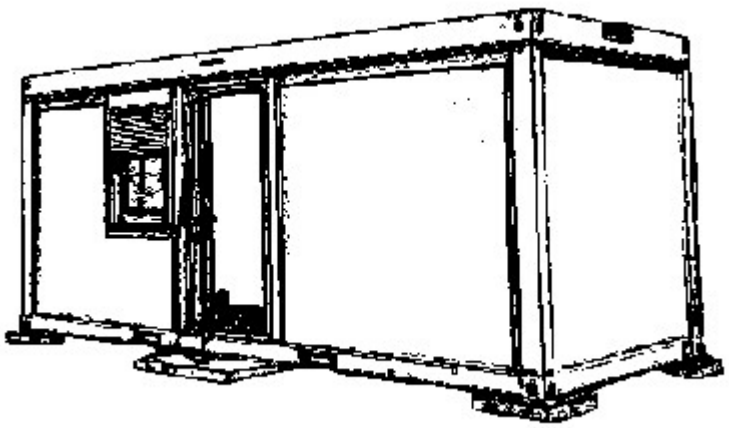
The simplest and most straightforward technique to move a container yourself is to tow it with a full sized pickup truck. This works best on fairly level terrain, and a half dozen or more 6-8" diameter steel pipes or uniformly round logs.

Enlist the help of one or two assistants to replace pipes or logs as the container moves forward. Use a thick slab of plywood or 1/4" steel as a base to rest a floor jack on and lift the leading edge of the container a few inches each time a pipe or log is replaced. Take care not to attempt this is very muddy or loose soils, as the pipes or logs may sink into the ground and lose their ability to provide forward motion.

Self movers can also build a container-buggy from steel stock that will insert through the forklift slots located on the bottom edges (of newer containers). This will require some engineering and assembly, but if you plan to relocate your container often, the buggy is a valuable tool to have available. You can purchase 12" casters and bolt, or weld them to the structural beams. Make sure to leave at least one side of the buggy assembly fastened with only bolts (so it can be removed from the high-low slots) if welding.

There are companies that manufacture container-buggies for the military, but these are expensive and designed for rolling units around on airstrip tarmac surfaces. The homemade buggy will function better on unpaved surfaces, towed with a full sized pickup truck or tractor.

Footings and Foundations



ISO Shelter on Cement Footings

Although not an absolute requirement, the design of your container structure will be improved with a solid foundation for it to rest upon. Some type of foundation will also reduce the corrosive effects of moisture over time.

Slabs, concrete footings, or simple wood beam footings are what I like best. You should choose one of these based on the
design of your building.

Oiled railroad ties are a simple and effective container foundation. They are cheap and readily available at most lumber yards. Regular pressure treated 2x8's also work well. Containers only require support at each of the four corners, but many builders that use concrete footings place 2 at mid-level for added stability. This is optional. If building on raw grade, installation of a 4-6" deep bed of gravel under any wood based footings (to assist in water drainage and discourage rotting of beams) is recommended. Bricks, and cinder blocks should be avoided for use as foundation material as these can crack and crumble.

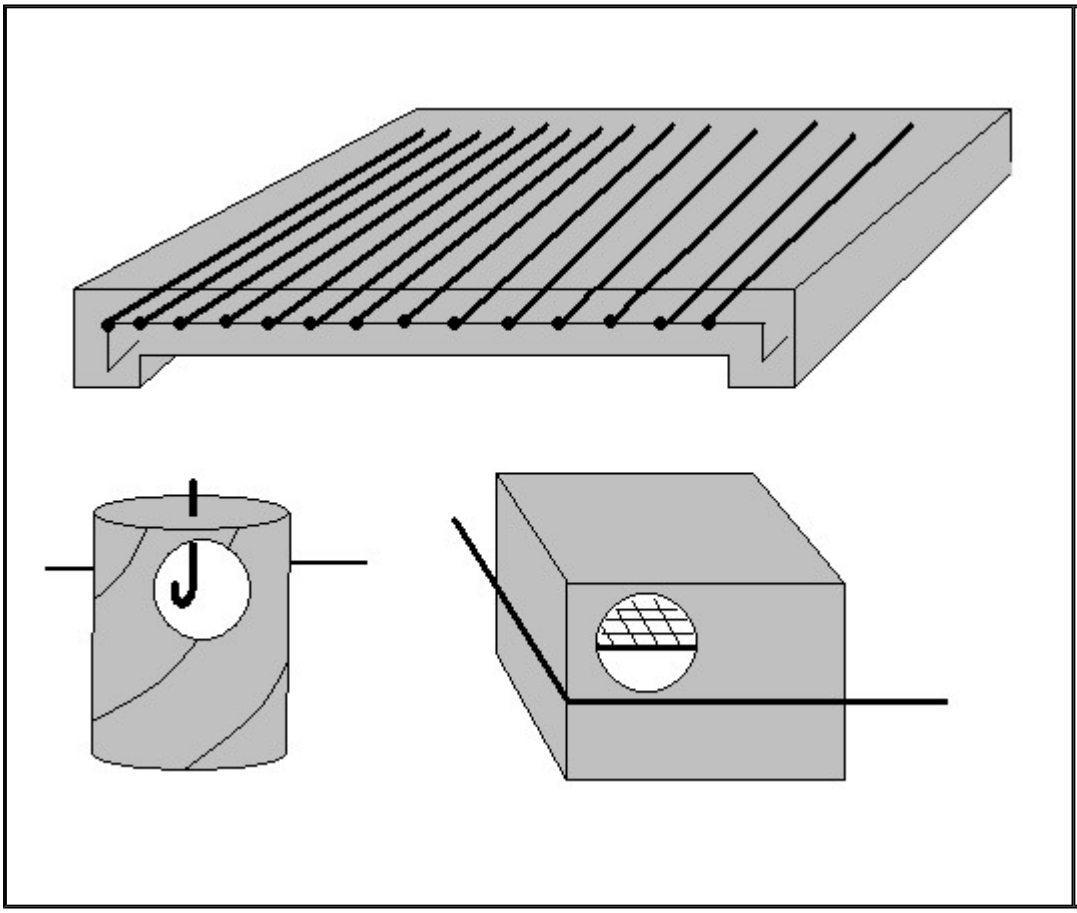
Poured concrete footings and slabs are the strongest foundations you can utilize. Since slab construction requires a large amount of ready mix delivered to your site, hiring a concrete crew to install it is best. All aspects from site preparation, form construction, rebar placement and finishing will be handled by a crew. You must provide information regarding load requirements of the slab prior to construction such as weight of building and placement of post anchors for decks and balconies, j-bolt anchors for securing container to slab, and PVC placement for utilities if any.

Here are some concrete estimates for various pads:

10'x25' 6" pad (for a 20 ft container) will require 125 cubic feet of ready mix
20'x24' 6" pad (for a 2 - 20 ft containers) will require 240 cubic feet of ready mix
20'x50' 6" pad (for a 2 - 40 ft containers) will require 500 cubic feet of ready mix

You can purchase 80 lb bags of pre mixed cement to make footings yourself. Each 2'x2'x2' footing will require about (6) 80 lb bags to fill the form. Fortunately these bags only cost a few dollars each. A few trips to the builders store may be required due to their excessive heft (don't blow out your shocks loading 50 bags of concrete into your vehicle). Always have a hose, and at the very least a wheelbarrow on hand for small concrete jobs. I would advise you to visit your local tool rental place and rent a portable cement mixer if you plan to do several footings in the same day. Have shovels, trowels, floats, sponges, and extra gravel on hand too.

A low cost substitute for a slab can be made by building a form as if for concrete, placing oiled or treated beam footings in place, then fill the form with crushed gravel. This will create a "lose slab". Use pressure treated decking lumber to build the form.



Pre-made fiber tubes can be used for pouring concrete footings, or you can build forms from wood. A footing can be
left flat to set the containers corner on, or a j-bolt can be set into the cement for anchoring. Steel containers weight 5000+ lbs, and are not likely to move easily, so anchoring it to the slab or footings is optional.

Install a 3" bed
of sand, a 3" bed of fine gravel, and a vapor barrier under all concrete. Wire mesh and rebar should be used inside all concrete applications.

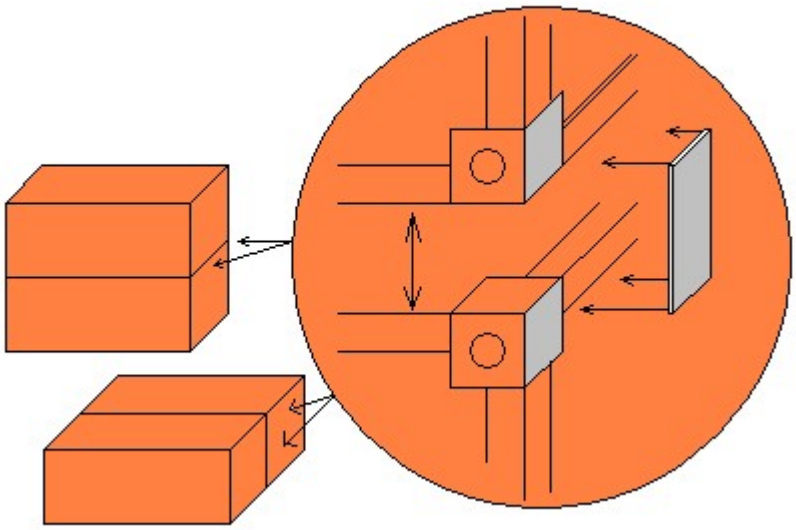
Six ton heavy welded steel jack stands can be purchased for about fifty dollars per set of two, and make nice permanent footings for use on a concrete pad or in a parking lot. You can setup a container without any foundation at all in a parking lot or on a pre-existing concrete paved surface.

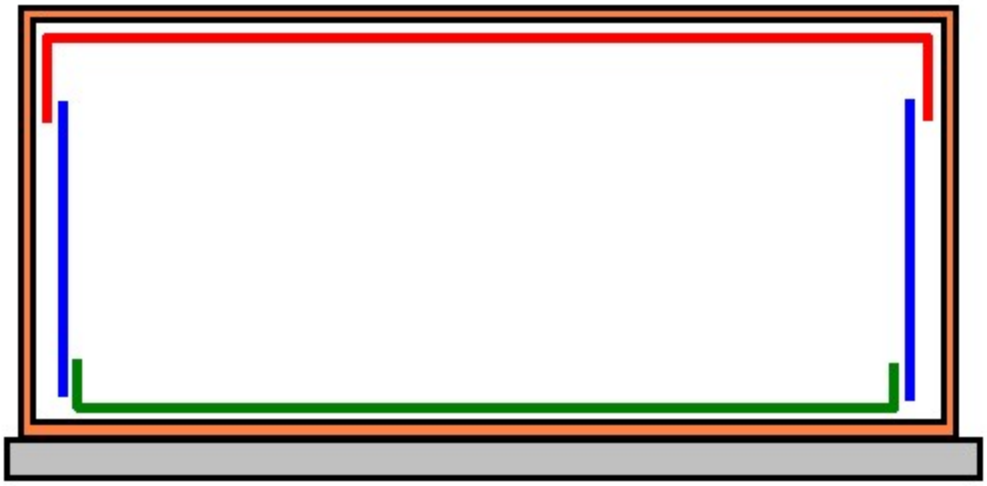
Hot summer sun can soften asphalt (black-top), so choose a footing material that offers a large 'footprint' (like railroad ties) if building or setting up containers on a this surface.

For 2-wide and/or 2 high container buildings, the first matter of concern is placement of the units.

Next they will need to be anchored to each other before further construction can take place. Containers are held together will clamps while in transit on the high seas. These are also effective for a building project, and can usually be purchased with the container from the same source. Coil spring clamps could also work, but I have not tried this myself.

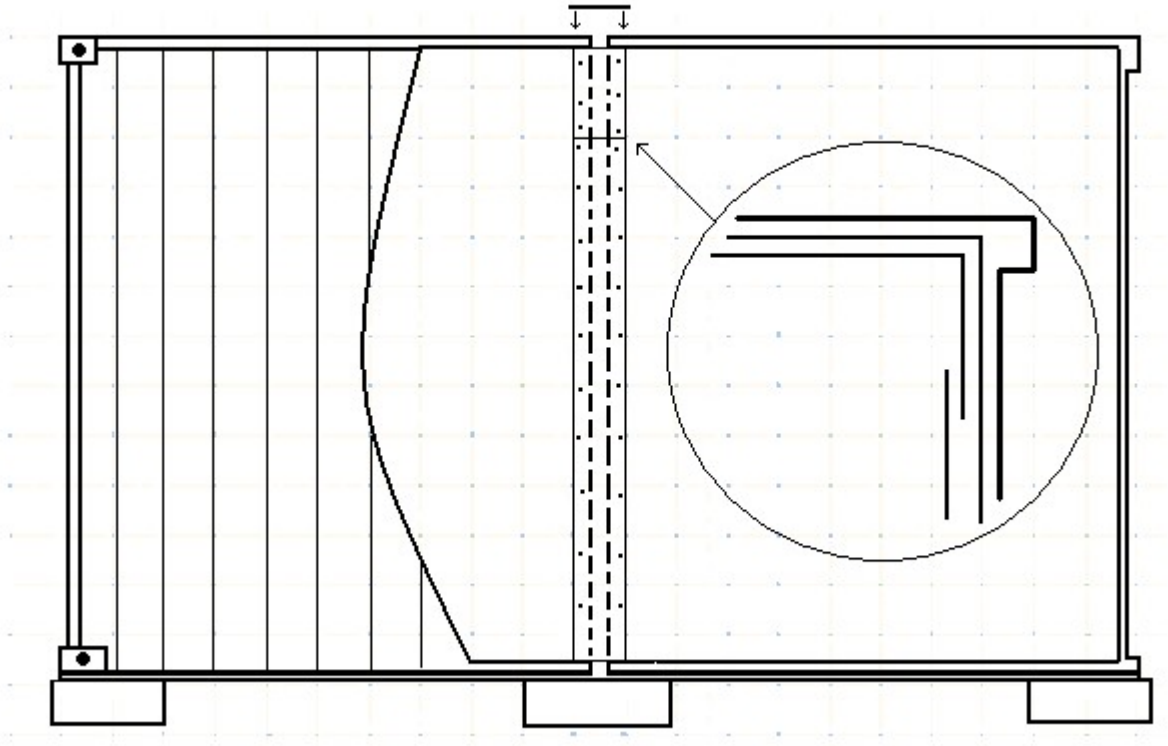
Welding 6"x10" 1/4" plates on top of the corner fittings (bridged across both containers fittings) will provide the strongest permanent anchor, and a clean
finished look.



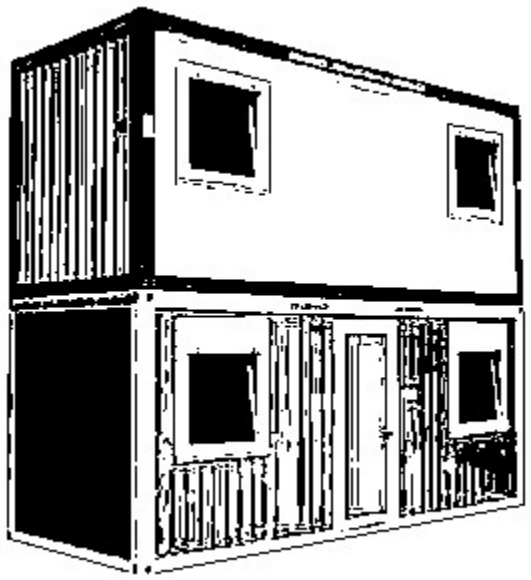


When constructing a 2-wide building where the interior will be 16' of open space, you will need to cut out the walls and seal the seam. Cut the walls away using a reciprocating saw. Removing small segments of wall at a time, gradually trim out all flashing leaving only the top, bottom, and side tubular frames. Then seal the containers together working from the inside.

Weld, or rivet new 20 gauge sheet metal (or salvage the steel removed from the walls) across the top (ceiling) seam running it down each wall a foot or so. Then seal the each side (the walls), overlapping to prevent leaking as you would with shingles. Lastly lay a thicker gauge of sheet metal on the seam of the floor. Then apply rubberized roofing or hot tar into the cracks of the seam from the outside. This will provide a water tight seal between the 2 segments of building. You might also consider installing a gable roof over the entire building as an added measure against rain and snow.



Fitting Out Containers



After your container is set-up, you can begin to fit it out with windows, doors, and interior element to your liking. This will involve cutting the 14 gauge (.075") corrugated steel sides of your container.

This is easily accomplished with the use of a reciprocating saw and steel cutting blades. After careful measurement, mark your cuts with a grease
pencil, then drill several 1/4" starter holes in each of the four corners. Buy a lot of extra blades because they tend to break often.

Do not damage the water-tight roofs of these units by cutting holes for vents or stovepipes, unless building a 2-level structure where a loft or stairway is called for. Route all utility and heater pipes
through the side of your unit with elbowed tubes.

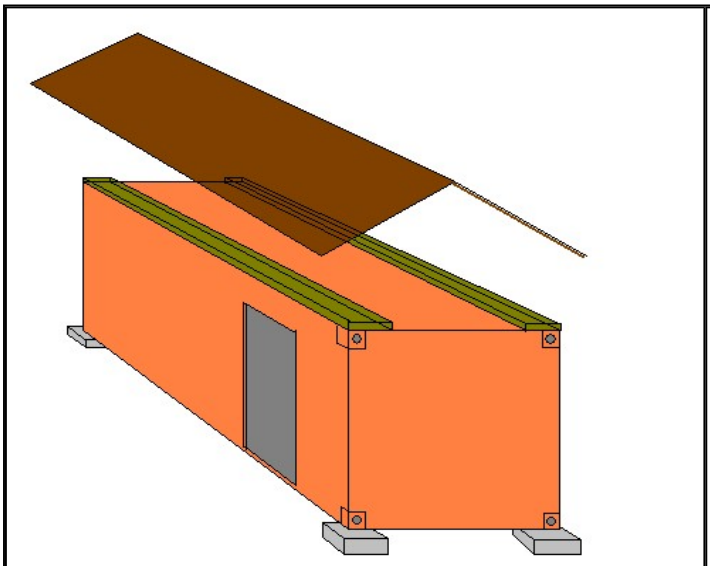
This avoids damage of a perfectly good water tight roof. [Container buildings do not require a roof, although a lumber built roof would prevent leakage from a stove pipe, I still prefer to keep the steel top free of holes. This is probably more of a personal preference on my part, you may feel differently.] PVC pipes for underground containers (shelter designs requiring vents) should also be routed via side walls, then elbow angled up and out of the ground from the side of the container. This will keep the roof intact, and reduce moisture seepage.

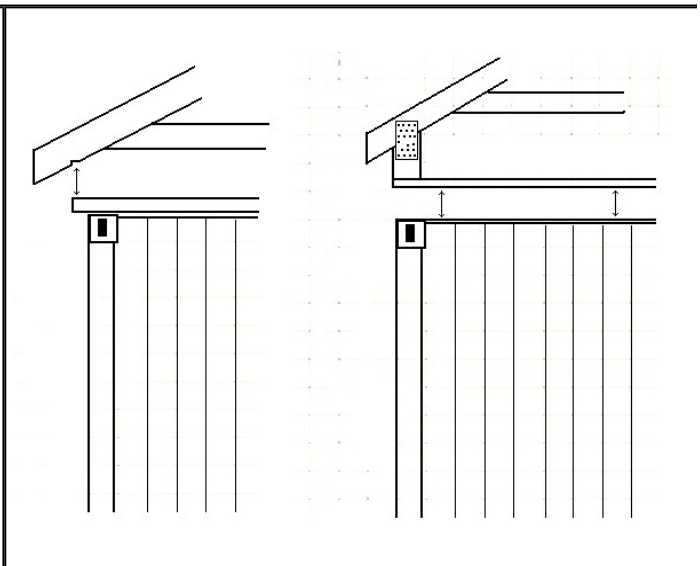
Additional gable roofs can be built with rafters or trusses. Always cut a 2x8 to the size of your building (longest side) and fasted it into the top of the containers side rail(s) with bolts. This will serve as the base (top plate) for your roof. You will need two of these, one on each side. Rafters can be notched for connection to the base plate, or rafter ties can be used.

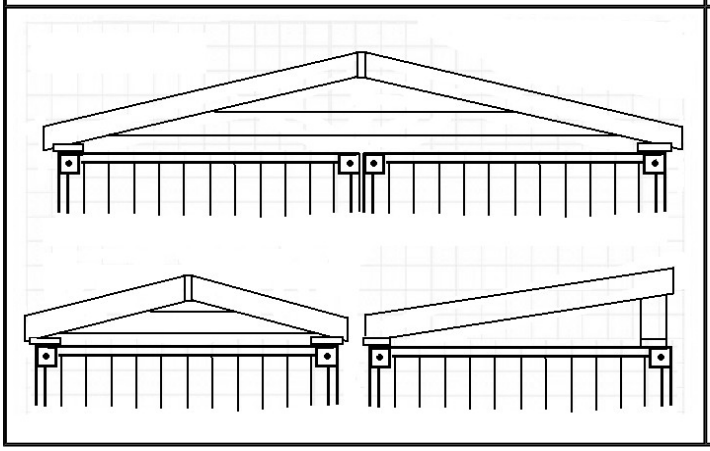
Roof designs can take many shapes depending on pitch, span and rise, and can become rather complicated. I will just cover a basic materials for a plain gable roof frame here (a simple triangle shaped roof).

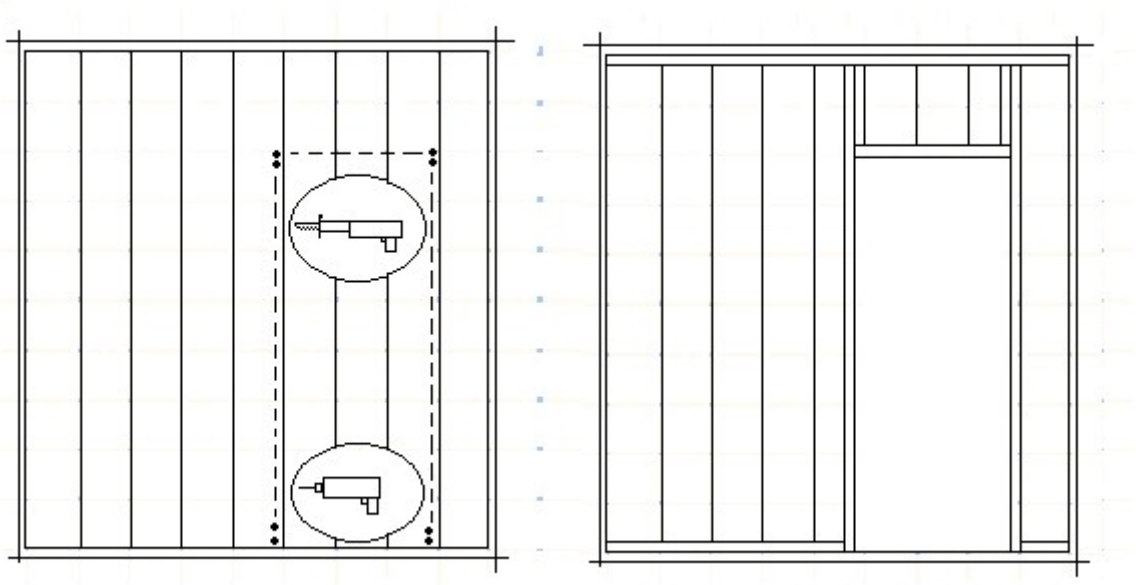
You can get away with using 2x4's for the roof framing on a single (8') container, but for wider buildings, or if you get lot's of snow, you should use 2x6's. Similarly, in heavy snow areas, you should utilize 16" on center framing as opposed to 24".

For 16" on center framing, multiply the length of the building by three-quarters, and add 1 (L x 0.75 + 1 = X rafters). For 24" on center framing, multiply the length of the building by one-half, and add 1 (L x 0.5 + 1 = X rafters). In addition to rafters you will also need the 2x8 top plates (as mentioned above), and a joist for each span. You can use a ridge board at the peak, or butt rafters together without it and connect them using truss plates (probably the cheapest and easiest method). There is a product called "Fast Framer Kit" available that includes hardware for installing a 8'x20' gable roof easily (I purchased three of these kits and they worked well). They cost about $40 per kit. Art-Deco roofs can also be installed on containers. These can be made from a variety of materials.









Framing container interiors is an easy task. To save money and valuable interior space, the affordable and easy to work with 2x2 can be used. Since the container already possesses all of its load-bearing qualities built-in, strength of the framing material is not an issue. This interior framework merely serves to hold insulation, paneling, windows and doors.

Avoid fastening 2x2 studs to the corrugated metal of the container with drilled holes, bolts, or other fasteners. This is not necessary, and will fill your water-tight walls with holes. The best method is precise cut studs that will fit snugly in place (they should require a light tapping into place with a hammer). Then run a bead of Liquid Nails style construction adhesive on each stud. Liquid Nails is effective on steel and wood. This method will produce more than satisfactory results, while saving time, effort, and money. Studs should be placed every 2ft-4ft to allow for easy attachment of standard 4x8 paneling or other interior sheathing material. Thin layers of fiberglass insulation placed under the paneling will help
retain heat in the winter time, and should be considered.

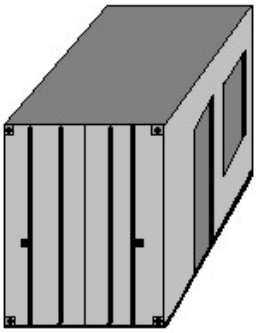
A 2x2 frame is adequate to support and mount a standard vinyl pre-made window. For windows and pre-hung doors requiring a wider mounting surface, you should build-up the frame using 2x4's or 2x6's inside the opening(s).

Exterior decks, supports, and roof framing aspects of your building can be built using standard readily available pressure treated decking lumber and connecting hardware. 4x4 beams and the corresponding concrete anchors should be used for support or overhanging 2nd story decks, and balconies. If using concrete footings, a separate footing is recommended for each beam.

12 Intermodal Container Building Plans

Special Safety Note: Air ventilation is a primary concern for anyone utilizing a shipping container for shelter. Newer containers are made with built-in air vent fittings, but older units are close to air tight.

When entering any unmodified container, you need to employ a safeguard against accidentally becoming locked inside (possible suffocation may result). The locking steel doors can be a great deterrent to would-be thief's, vandals, and also mother nature, but they must be temporarily secured to the sides (in their open position) to prevent accidents. This safety measure can be discontinued after the first cuts (for doors, windows, etc) are made.

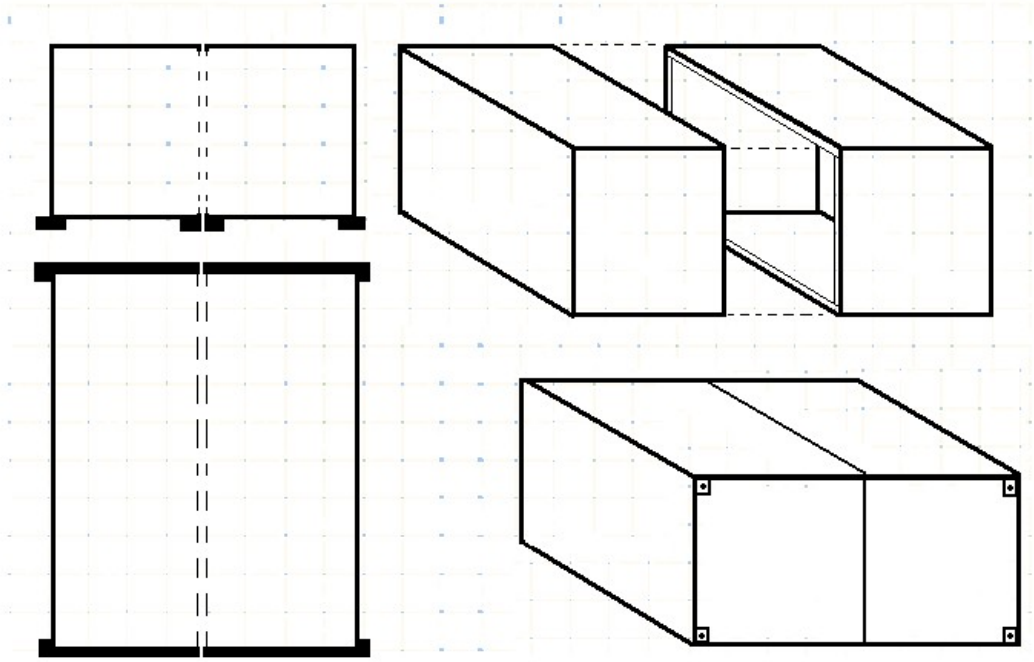


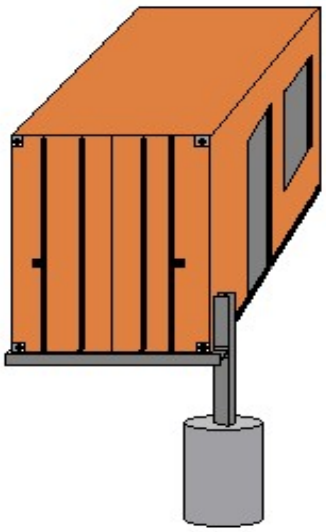
Standard single design. This is a single 20 ft container with wood foundation footings, two windows, and a entry door. The steel cargo doors remain intact on this design, but can be opened to accommodate oversized materials if using as a workshop.

The cargo doors can also be removed and replaced with a 6' patio slider glass door. Interior is
fit-out with 2x2 framework, insulation, and decorative wood facade paneling.

Two 20 ft units placed side-by-side provides a spacious 16'x20' building. Containers are set in place on footings, then anchored together by welding 1/4" plates on top of the corner fittings.

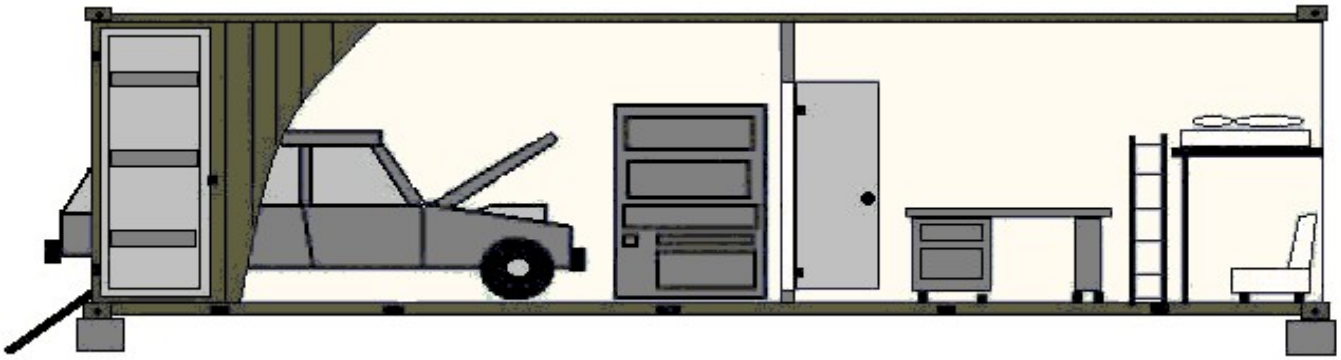
Trim out the inside walls using a reciprocating saw after units are secured together in place. Seams are then sealed from the inside with sheet metal, and hot tar is applied to the outside gaps.





Flood-proof design offers a reassuring structure for areas prone to high water. Build the I-beam framework 4'-5' above the ground, and use 2'x2'x4' wood molds or 55 gallon drums for the concrete forms.

Lift your 20 ft container into place with an excavator after concrete sets, and secure with welded plates

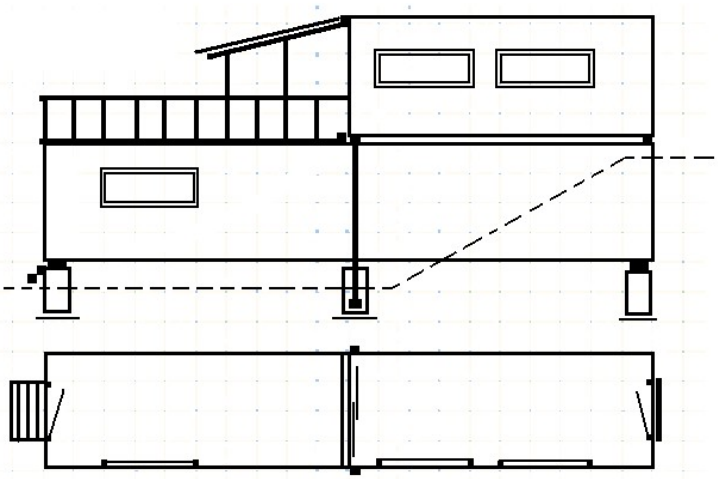


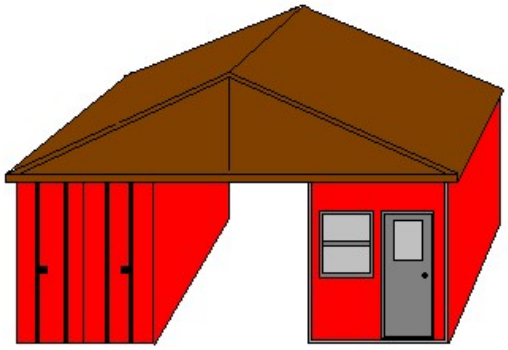
40 ft container modified to serve as an auto repair shop. Back section of unit has office and sleeping area. Bulkhead dividing wall is built using standard construction methods, and secured in place with Liquid Nails. This design can serve many purposes from a basic workshop, to small car or motorcycle repair facility. Also worth mentioning, is the secure-locking nature of containers. These units provide a high level of security for expensive vehicles and tools. Bars can be welded over window openings for security. For the cost, the unit may prove a justified expenditure.

20 ft desert design has a art deco gable roof covered with solar panels. Set-up shades the container from hot desert sun, while simultaneously generating all required electrical power for the occupant. Use 12 volt deep cycle batteries connected to a DC-to-AC power inverter. Unit has steel shipping doors intact, but these can be opened to provide a breeze and a "outside patio" feel in the insect-free desert environment. Another option is to replace cargo doors with a 6' glass patio slider.

Split level design for the serious builder. Building consists of a 40 ft container half buried in the side of a modest slope, with a 20 ft unit serving as the second floor.

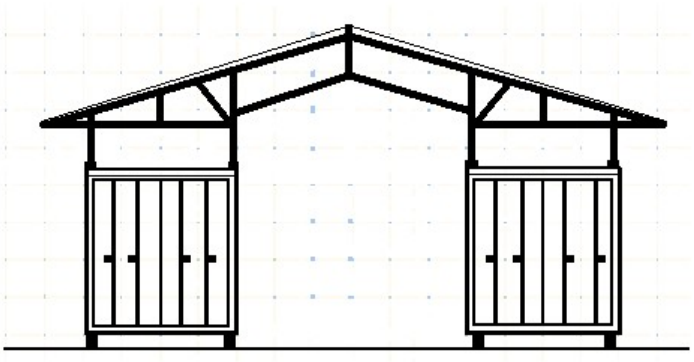
Pressure treated decking is used on the open side creating a patio area complete with 6' glass slider doors, and corrugated metal roof overhang. Sections of the container that will be covered with grade are painted with rubberized undercoating spray.

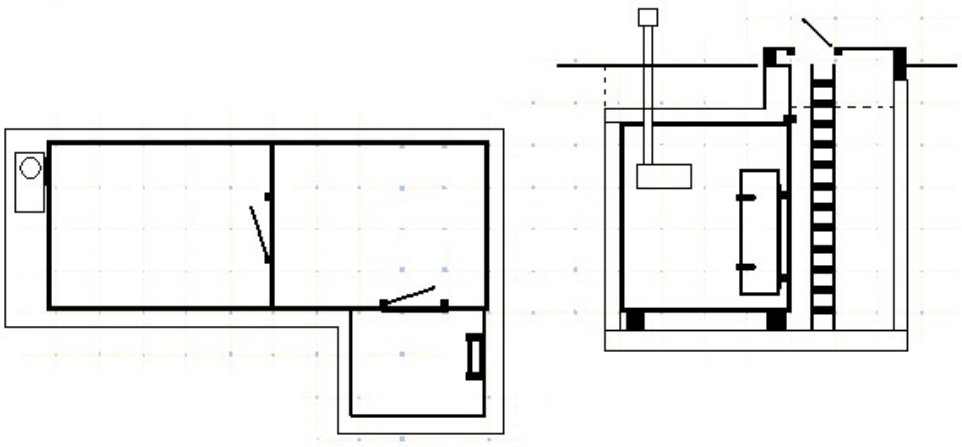




This is a design that maximizes the effective space of 20 ft units. The Super Carport has a peaked truss roof covered with corrugated metal roofing panels, space for your car, motorcycles, and a workshop.

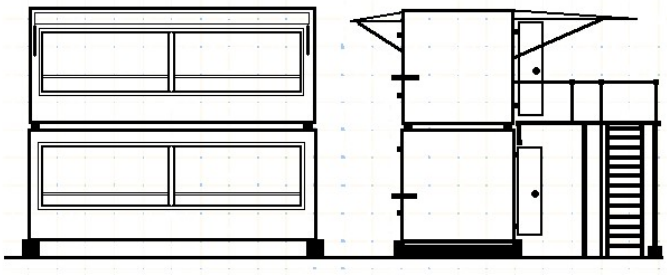
The Super RV Cover is similar to the Super Carport, with extended main truss beams to accommodate tall RV's and boats for storage. Use 40 ft containers to create a massive utility structure. This design also works great for permanent RV living. Parked RV or 5th wheel is kept out of the damaging UV rays, while the containers on each side offer several options. Owner may choose to build: large bathroom's, whirlpool and sauna room, billiards room, bar, workshop, home theater, or bunkhouse in one or both units. Using such a design would allow you to easily expand the living and/or storage area of your parked RV or 5th wheel.

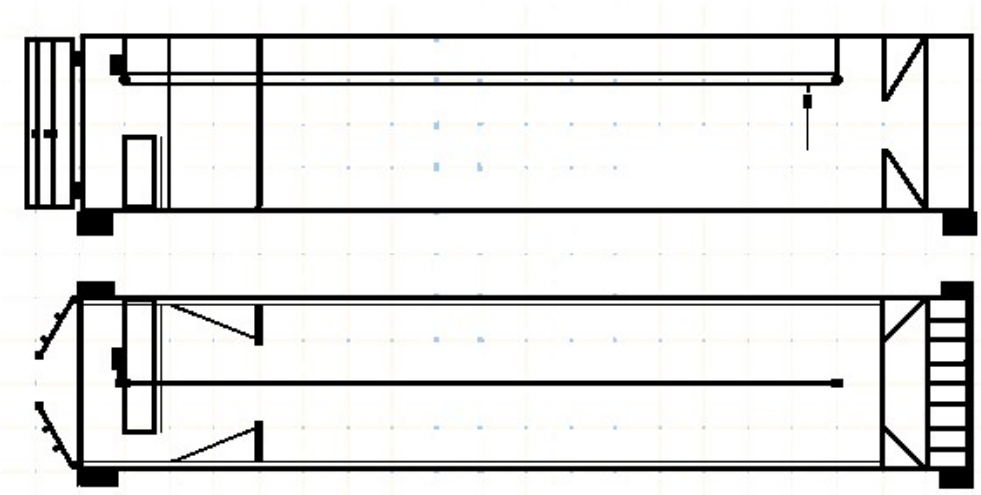




Underground bomb shelters can be built using a 20 ft container painted with rubberized undercoating spray (to prevent corrosion). This design requires an excavator with shovel to dig the hole, lower the container in, and then fill the remaining gaps with fine gravel creating a drainage wall around unit. Steel beam framework and 1/4" plate is used to create the entry space under ladder and hatch. Note vent tube on container. Loss of oxygen is a risk with this design if not properly constructed. Vents are required. Use at your own risk.

Two 20 ft stacked units for skeet or trap shooting. Design includes a pressure treated wood deck and staircase located on backside. This set-up could also be used for sporting events, providing a second story booth for announcers, and first floor unit for concessions or equipment storage. Possible applications: skeet & trap clubs on a budget, dirt-bike racing, new extreme sports facilities, horse races, and high schools.

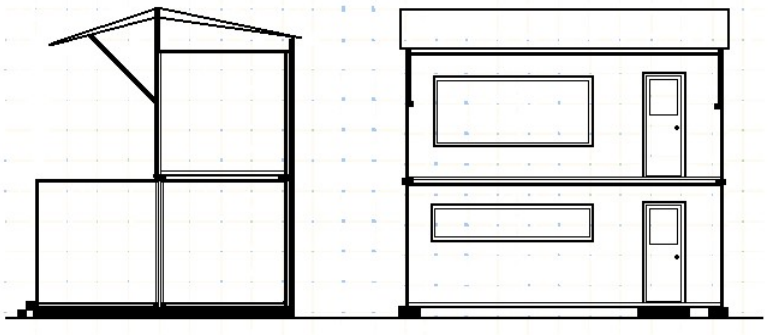


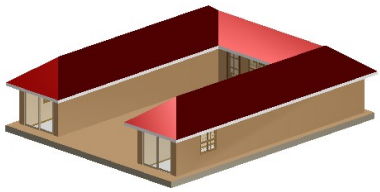


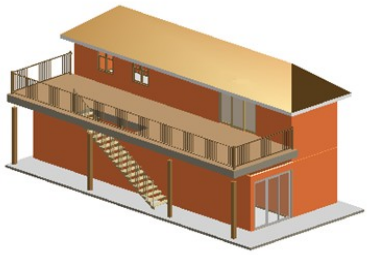
This 40 ft handgun range could prove useful for police departments or other agencies. Could be used as a temporary solution for lack of space, or as a low cost range for departments on a budget.

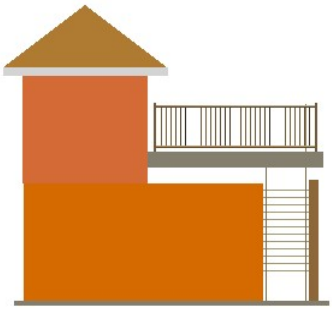
Other possible configurations include a two lane bowling alley, or small archery shop with target range.

Triple design 3- 20 ft containers form a great little multi-level cabin, cottage, or guest house on your land. Connected walls can be trimmed out providing a large open space. Trim-out half of the connected roof-floor (of stacked units) to create a loft. Add wood stairs, a ladder, or a spiral staircase for second floor access. Open terrace can be designed as a screen porch or weather resistant, lumber-built dormer.









Military Container Handbooks and ISO Shelters

MIL-HDBK-138 is the U.S. Military Intermodal Container Handbook, otherwise known as; The Guide to Container Inspection for Commercial and Military Intermodal Containers. Published by the Department of Defense, it is updated often with the latest pertinent intermodal information. As a civilian container builder, you will find the information presented in the handbook to be quite valuable. This knowledge of intermodal chassis construction, and inspection for structural damage, can be extremely useful not only in building, but when purchasing used containers. It is recommended that anyone interested in purchasing new or used containers, or beginning a container building project, spend time studying MIL-HDBK-138 beforehand.

JOCOTAS (Joint Committee on Tactical Shelters), along with The Defense Ammunition Center & School, is a major contributor to the constant revision of this handbook. JOCOTAS was formed in 1975 under office of the Secretary of Defensewith purpose of streamlining the design and deployment of military shelter systems with implementation of ISO rigid wall (container) shelters and ISO deployment systems for non ISO shelters.

A sample of the JOCOTAS Charter from March 2003 states that their purpose is: A) to advance the state of the art in shelter design, and shelter ancillary equipment, B) search for common solutions to identified user needs, C) eliminate duplication of shelter RDT&E, D) create a standard shelter family and maximize it's use within DOD, E) share information and expertise to solve shelter problems, F) work to promote evolutionary change in processes used for shelter development, G) assist the services (branches of military) in procuring shelters in the most streamlined and cost effective way, H) assure shelters are compatible with commercial and military transportation equipment for worldwide deployment, I) provide a forum for interaction between JOCOTAS and industry. The charter also states responsibilities and objectives including: A) to coordinate multi-service plans for shelter RDT&E, modernization and production programs, B) maximize opportunities for joint requirements, joint development programs, and joint funding, C) promote cost effective, streamlined shelter acquisition and procurement, D) maximize opportunities for joint procurement and central logistics support, E) maintain the DOD standard family of soft wall, rigid wall, and hybrid shelters, and add to the family to meet multi-service requirements, F) maximize the use of standard shelters within DOD; require a waiver to buy non-standard shelters, G) prepare and update annually a 5-year multi-service RDTE and production plan, H) sponsor/assist the Defense Ammunition Center & School in the extensive review and revision of MIL-HDBK-138 to include re-inspection criteria for ISO shelters and changes to the Convention for Safe Containers (CSC) Training Course on Re-Inspection of ISO Shipping Containers to include ISO Shelters.

The U.S. Military has utilized container shelters and intermodal movement systems at an increasing rate since the 70's. The Department of Defense was an originator of containerization in WW2, but, as with any massive logistics design operation, it has taken 50+ years to work out bugs and consolidate techniques. The current line of DOD (Dept of Defense) shelters that have emerged have served their purpose quite successfully, but, as is the nature of a state of the art military, will likely soon evolve. Intermodal chassis will be the likely foundation for these new designs as well.

Prior to the formation of JOCOTAS, over 100 different types of shelters were being used by the four military branches, creating a severe logistics mess. Since it's creation, JOCOTAS has successfully condensed the
active number of rigid wall tactical shelters to 17 styles. These include every type of shelter you could imagine, from portable hospitals, to one-man tents. A handful of these 17 shelter models are built on the standard (20 ft) ISO container chassis. These shelters are essentially civilian freight containers, painted desert or woodland camouflage, with some minor additions such as power hook-ups, air conditioning, and built-in leveling jacks.

From the JOCOTAS catalog, we find two shelter designs based on ISO container chassis;
a) ISO, Shelter, Tactical, Nonexpandable S-781/G (60 amp) Stock # 5411-01-136-9837, and
b) ISO, Shelter, Tactical, Nonexpandable S-782/G (100 amp) Stock # 5411-01-294-6390.
Sample of design specs for S-781/G & S-782/G model ISO Shelters include: interior dimensions of 19' 1" long x 7' 7" wide x 7' 1" high. Exterior dimensions of 19' 11" long x 8' wide x 8' high. Weight of 3900 lbs, payload of 11,100 lbs, gross weight of 15,000 lbs. Constructed with a honeycomb core, interior lights, breaker box, and leveling jacks. Entrance via single personnel door on one end.

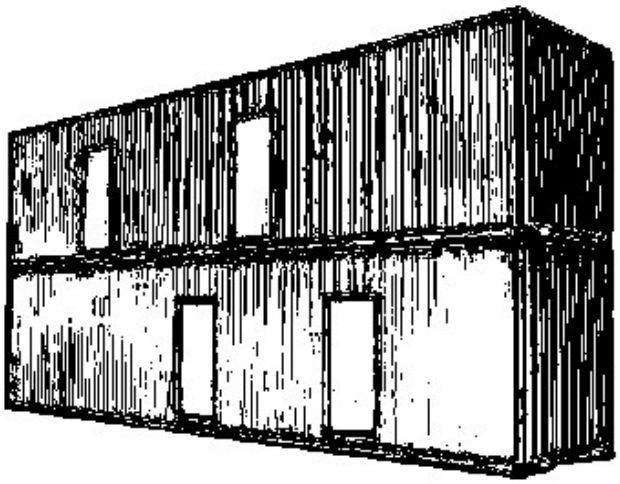
Of course, in any real world theater of war, deployed troops must often modify or even build equipment themselves. Visions of the WW2 era American Sherman tank, with a crew-built outer skirt of sand bags (to deflect rounds from German Panzer tanks) emerge. Modification, and innovation of standard issue equipment in times of combat has always been a freedom enjoyed by the U.S. Military. ISO Shelters are no exception. Raw shipping containers are being modified, turned into sleeping quarters, dining halls, and repair facilities, by U.S. soldiers in Iraq and Afghanistan at the time of this writing. Stacks of empty 20 ft containers are a common sight when the U.S. army is mobilized . A few enterprising soldiers could assemble a rather comfortable non-regulation container shelter in short period of time with all these empty cargo boxes.

From MIL-HDBK-138: [Typical end-opening steel containers are the most commonly used by the Army. These containers completely enclose their contents by permanent steel structures and provide cargo loading access through end opening doors. Typical steel containers are 20, or 40 feet long by 8, 8.5, or 9.5 feet high. The standard width of an intermodal container is 8 feet. The walls of a typical steel container are usually constructed of corrugated sheet steel panels that are welded to the main structural steel top and bottom side rails and end frames. The end frames are fitted with standard corner fittings (steel castings) at all eight corners that are welded to the four corner posts, top and bottom side and front rails, and rear door
sill and header.

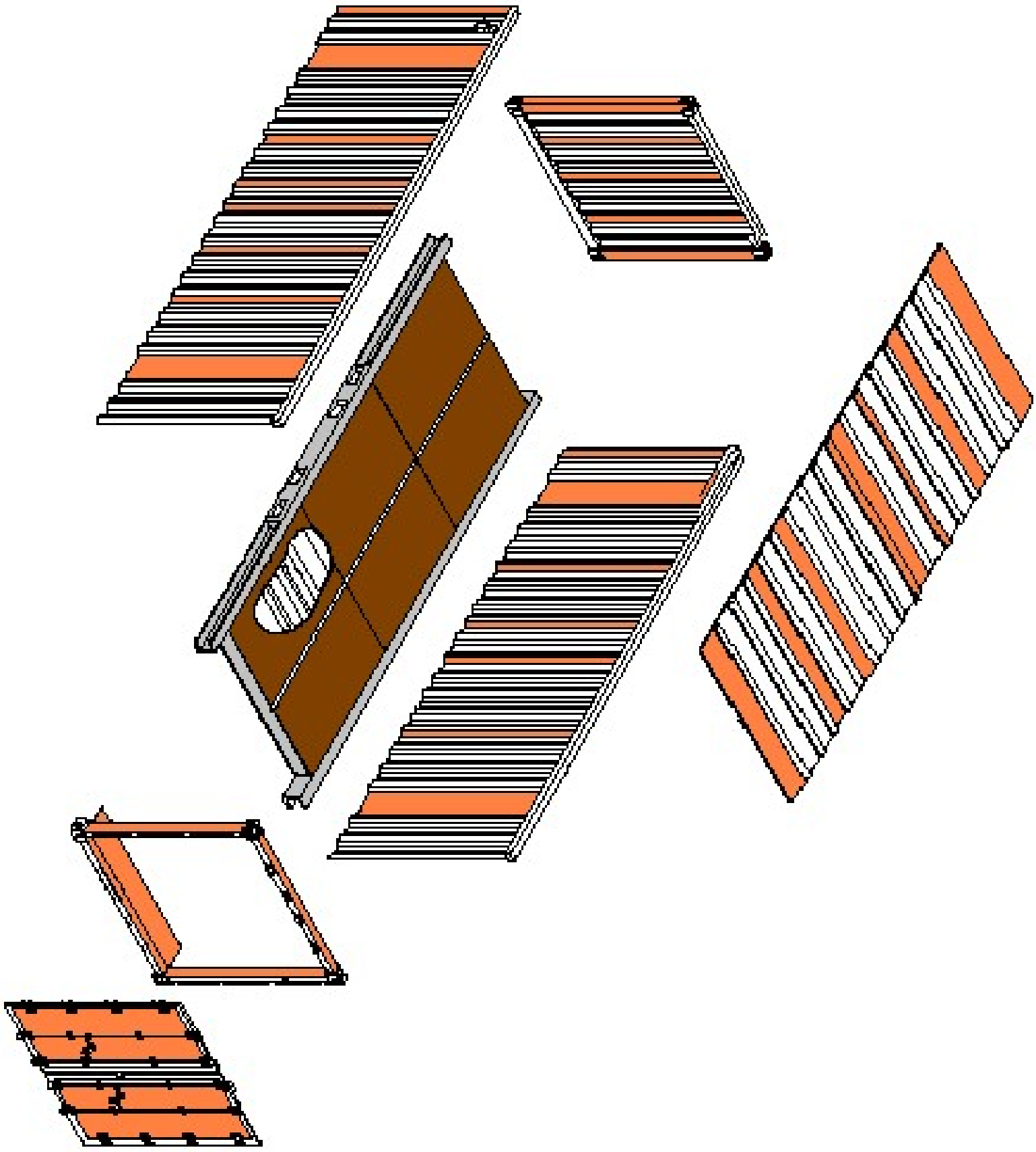
The roof is usually constructed of either flat or corrugated sheet steel panels welded to the top side and end rails and door header and may have roof bows for support. The doors are usually either shaped steel frame with steel panels or plymetal (steel faced wood) panels fitted with locking and anti-rack hardware and weather-proof seals (gaskets). The flooring may be soft or hard laminated woods, planking, or composition material either screwed or bolted to the floor cross members. The floor cross members may be box, C, Z, or I shaped steel beams bolted or welded to the bottom side rails. Some containers are configured with an all-steel flooring or a combination of wood and steel.

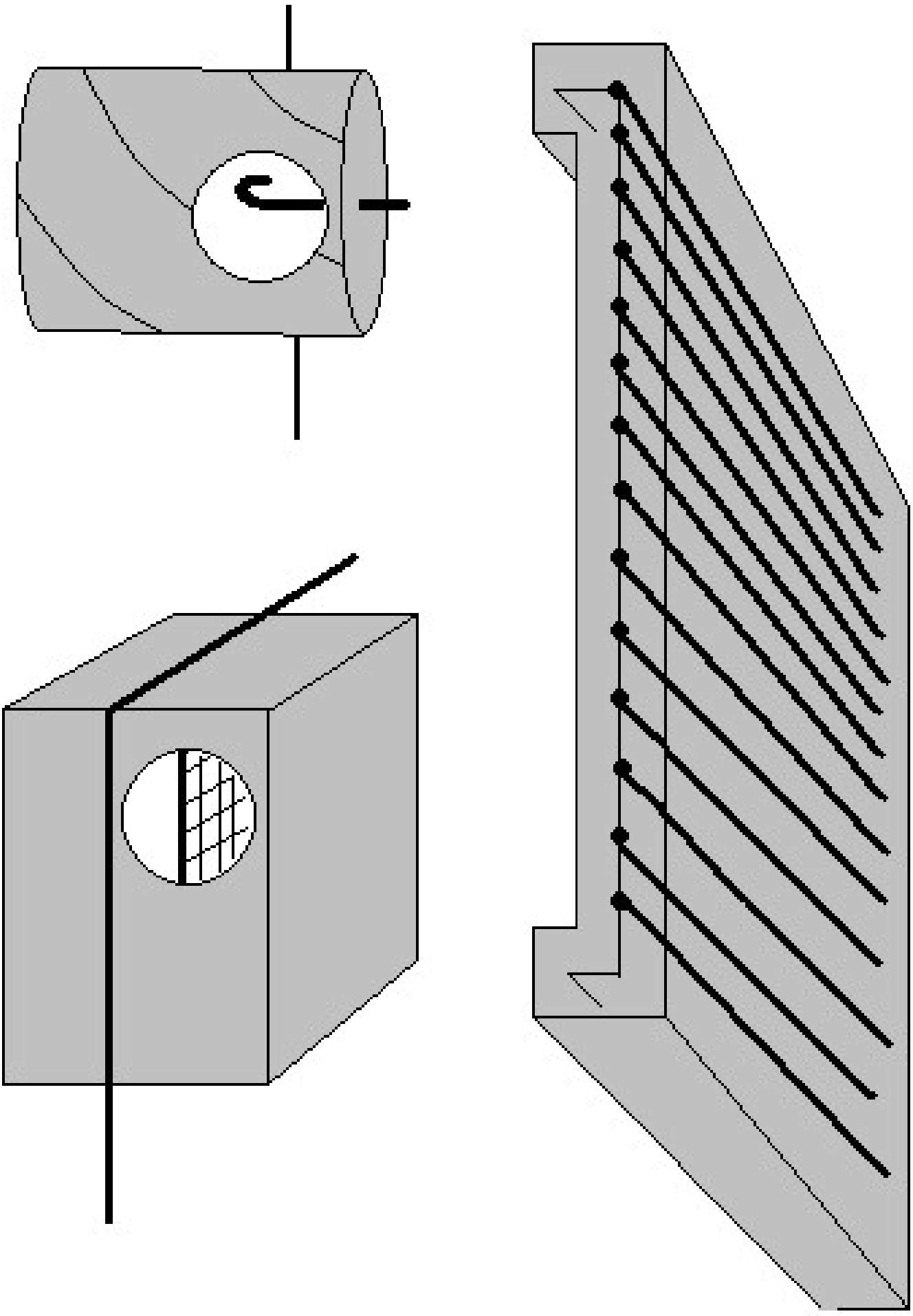
An intermodal freight container is primarily handled via connection with its internationally standard corner fittings; however, many steel containers are also provided with empty and/or loaded capacity forklift pockets to improve container handling
versatility.]

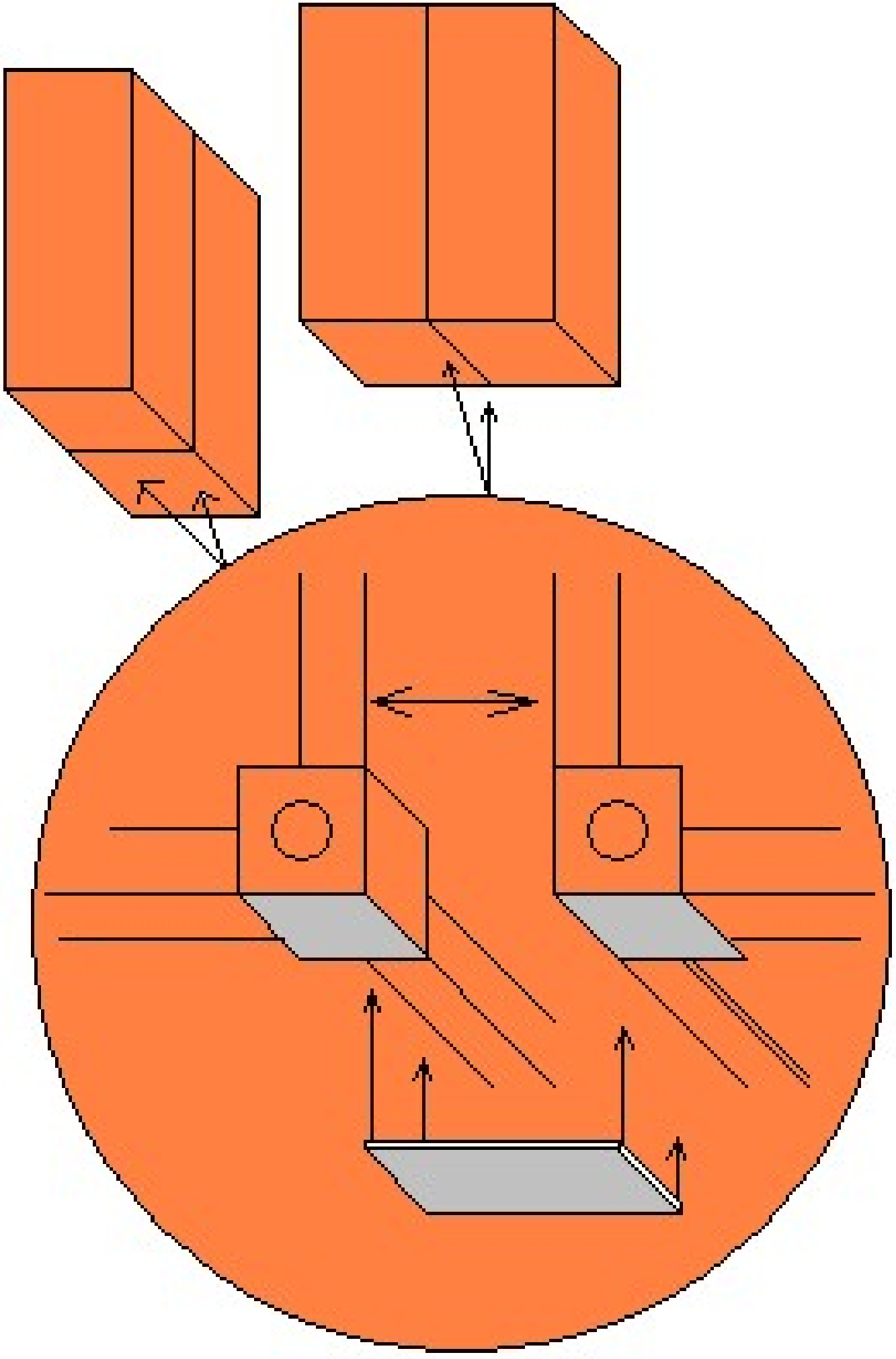
The Guide to Container Inspection for Commercial and Military Intermodal Containers mainly provides instruction in two important areas; 1) structural design of common shipping containers including but not limited to exploded views of components, close up diagrams of rails and corner fittings, hardware, top and bottom decks, flooring, and doors 2) locating old repairs, steel patching, welding, inspection of said repairs for structural integrity, and also performance of new repairs on steel and aluminum container frames and bodies including welding and riveting. Other aspects of container use that are covered in the manual, while not an absolute requirement to the container builder, are also helpful in expanding individual scope and
knowledge.

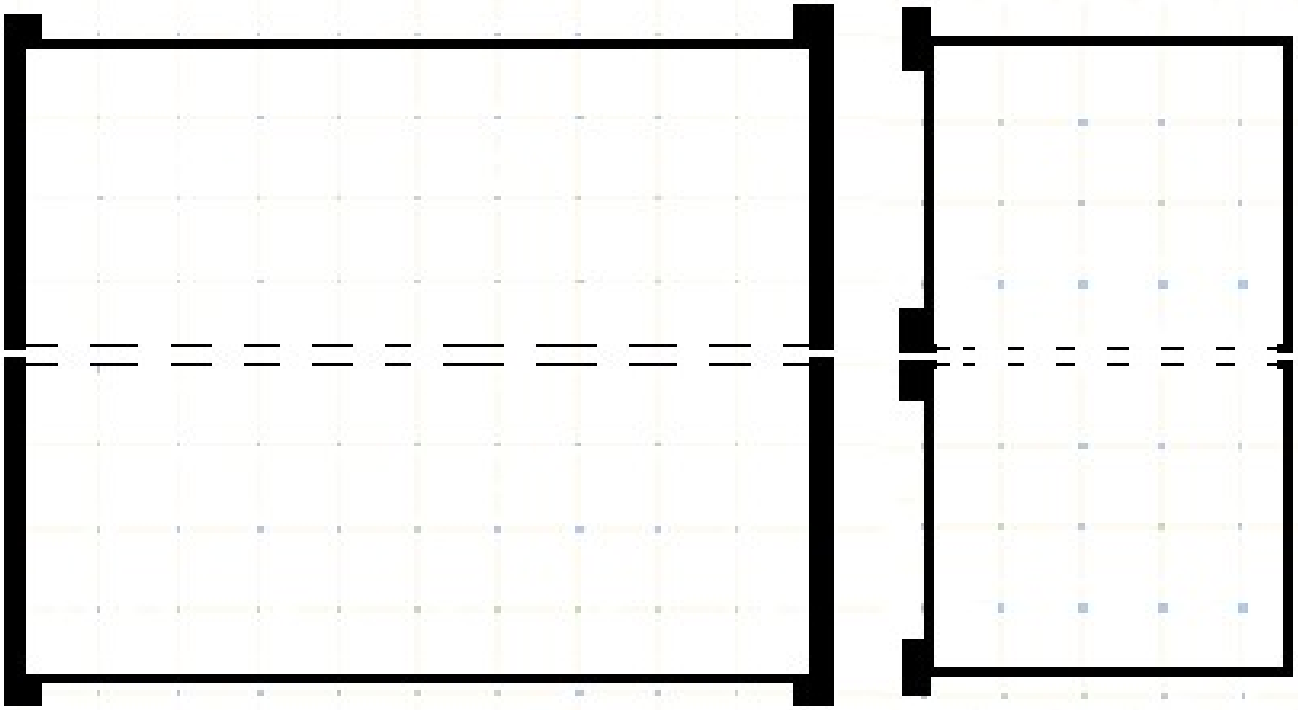


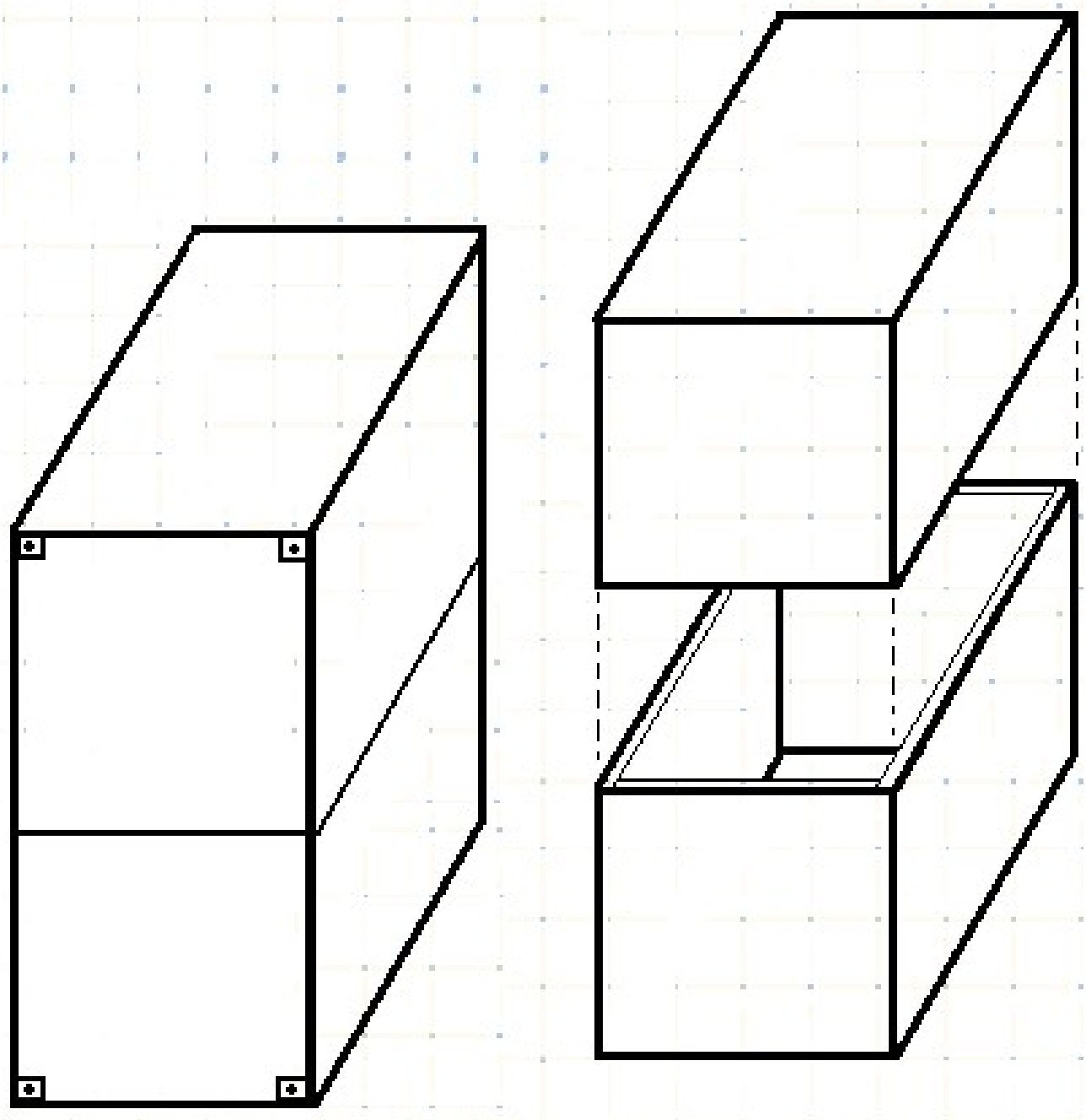
Large Images

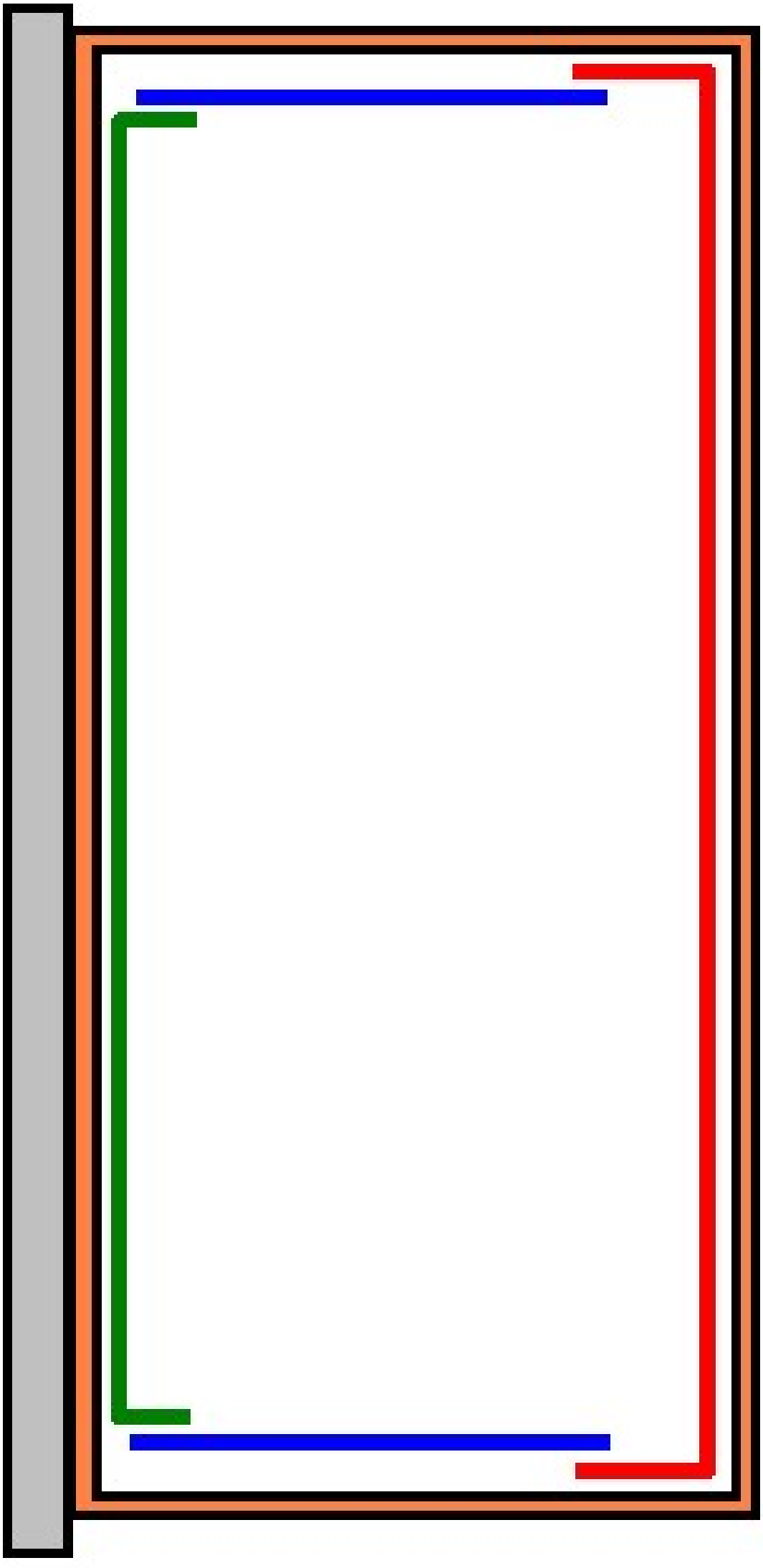


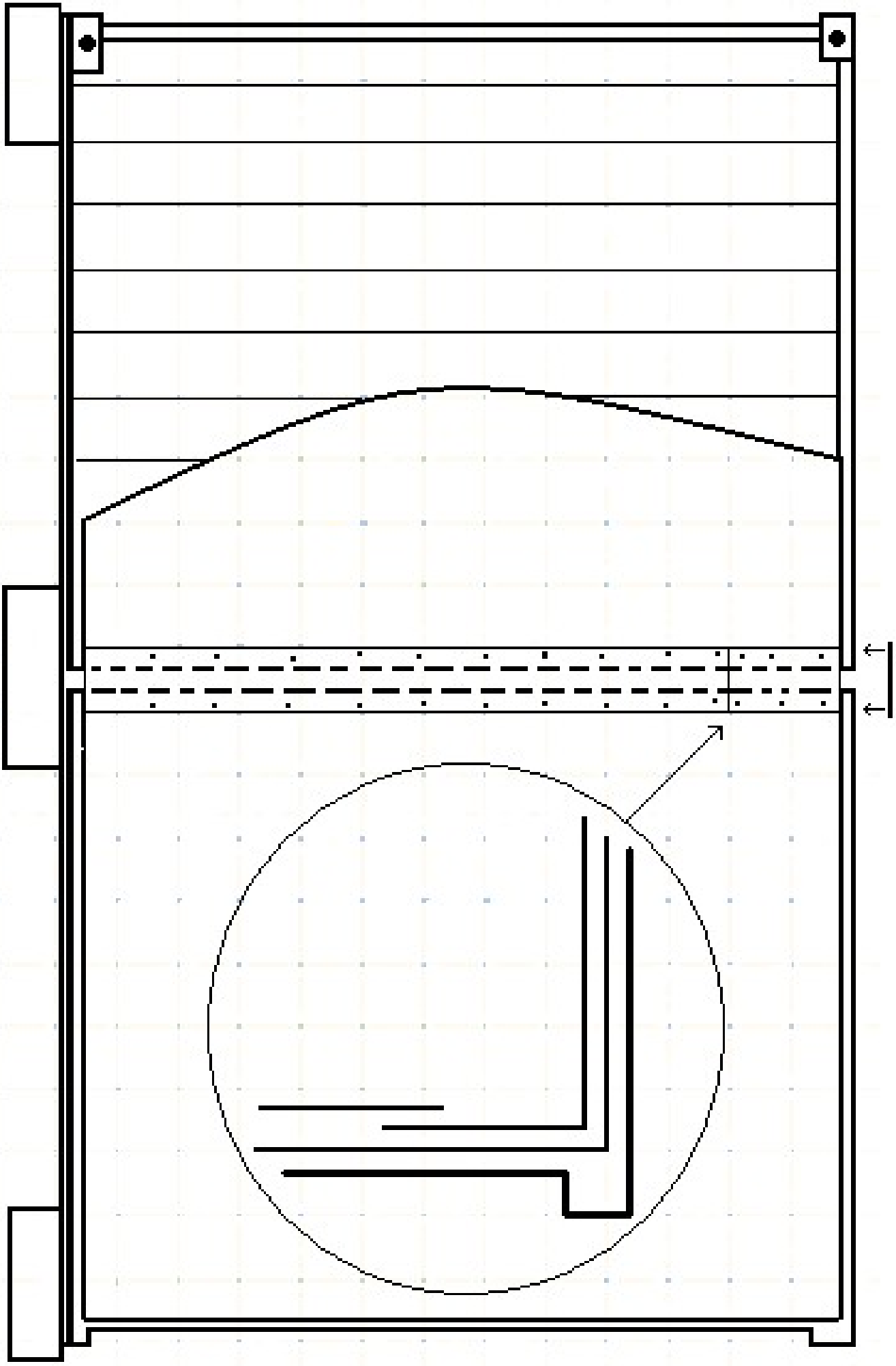


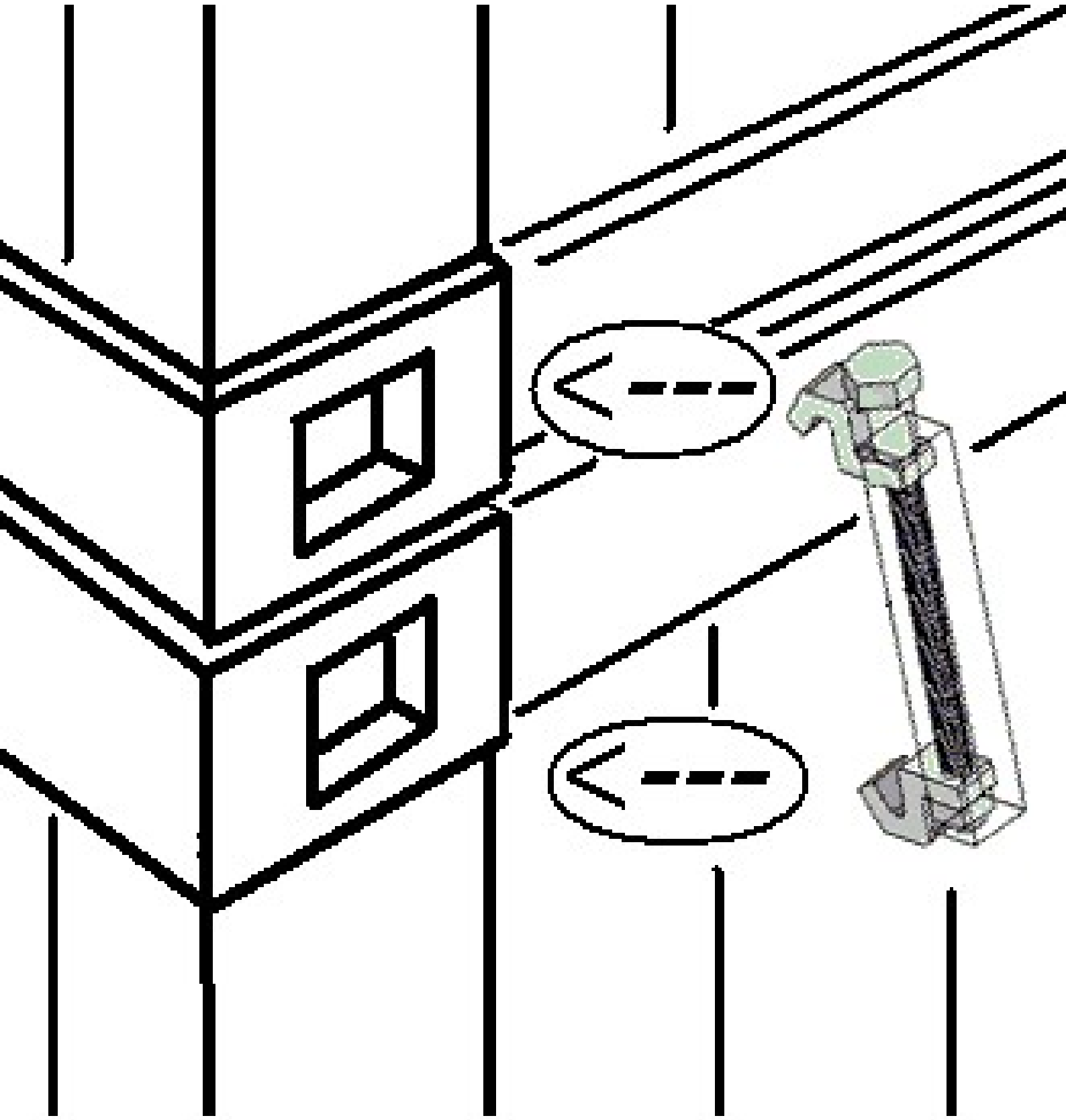


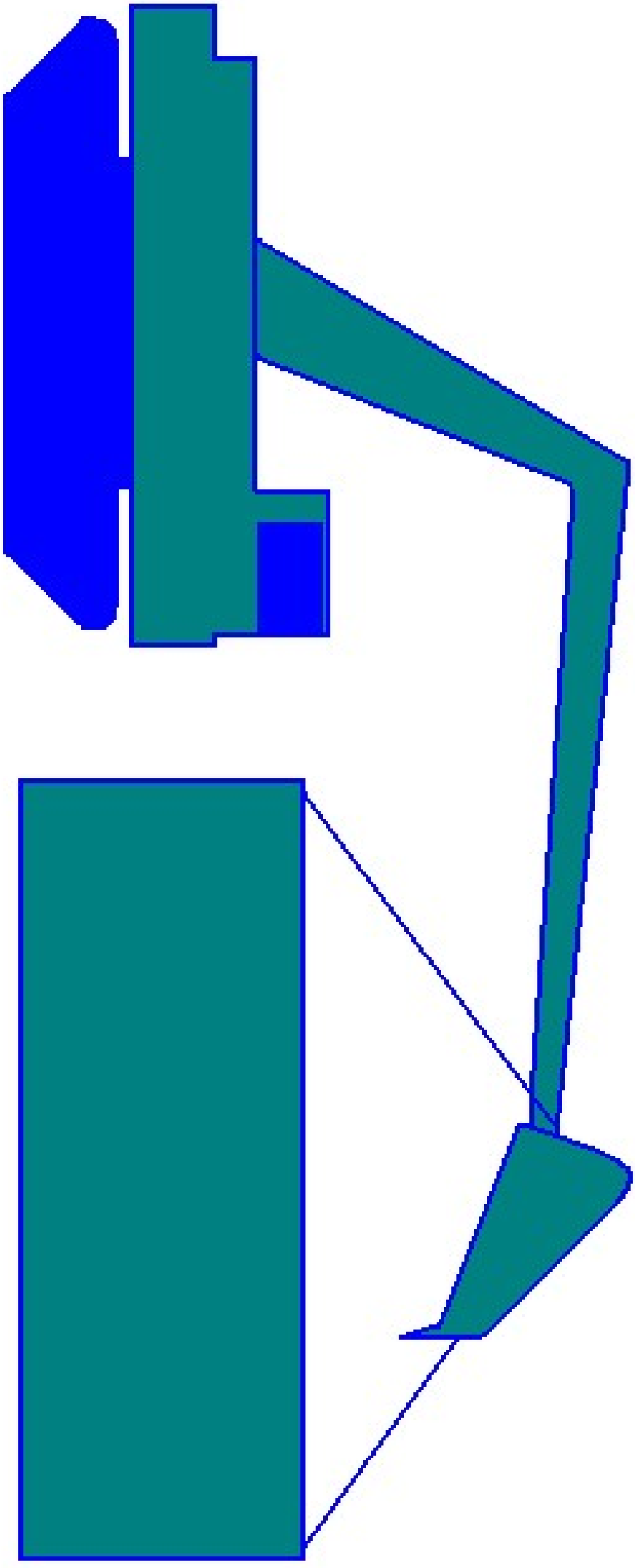


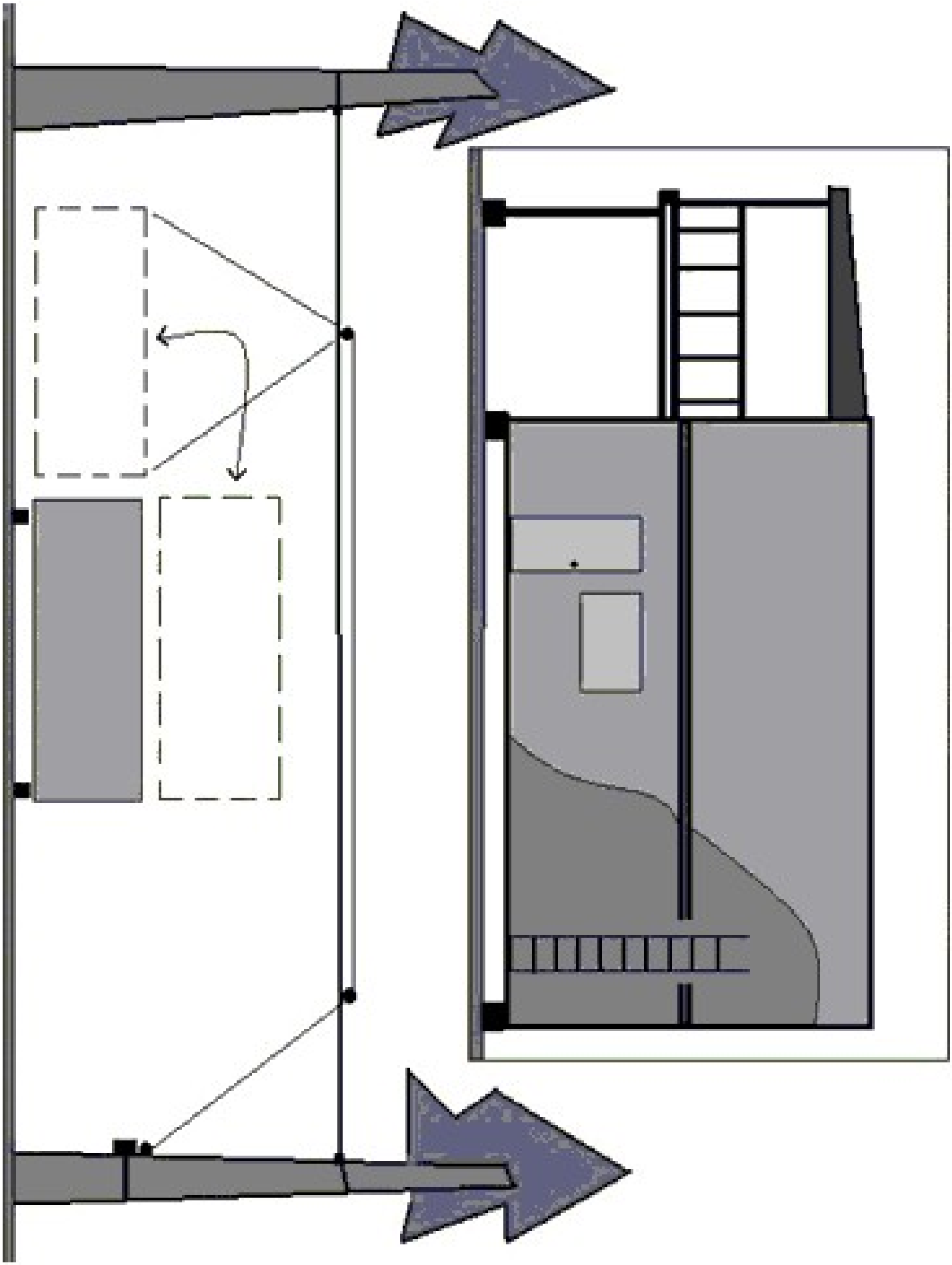


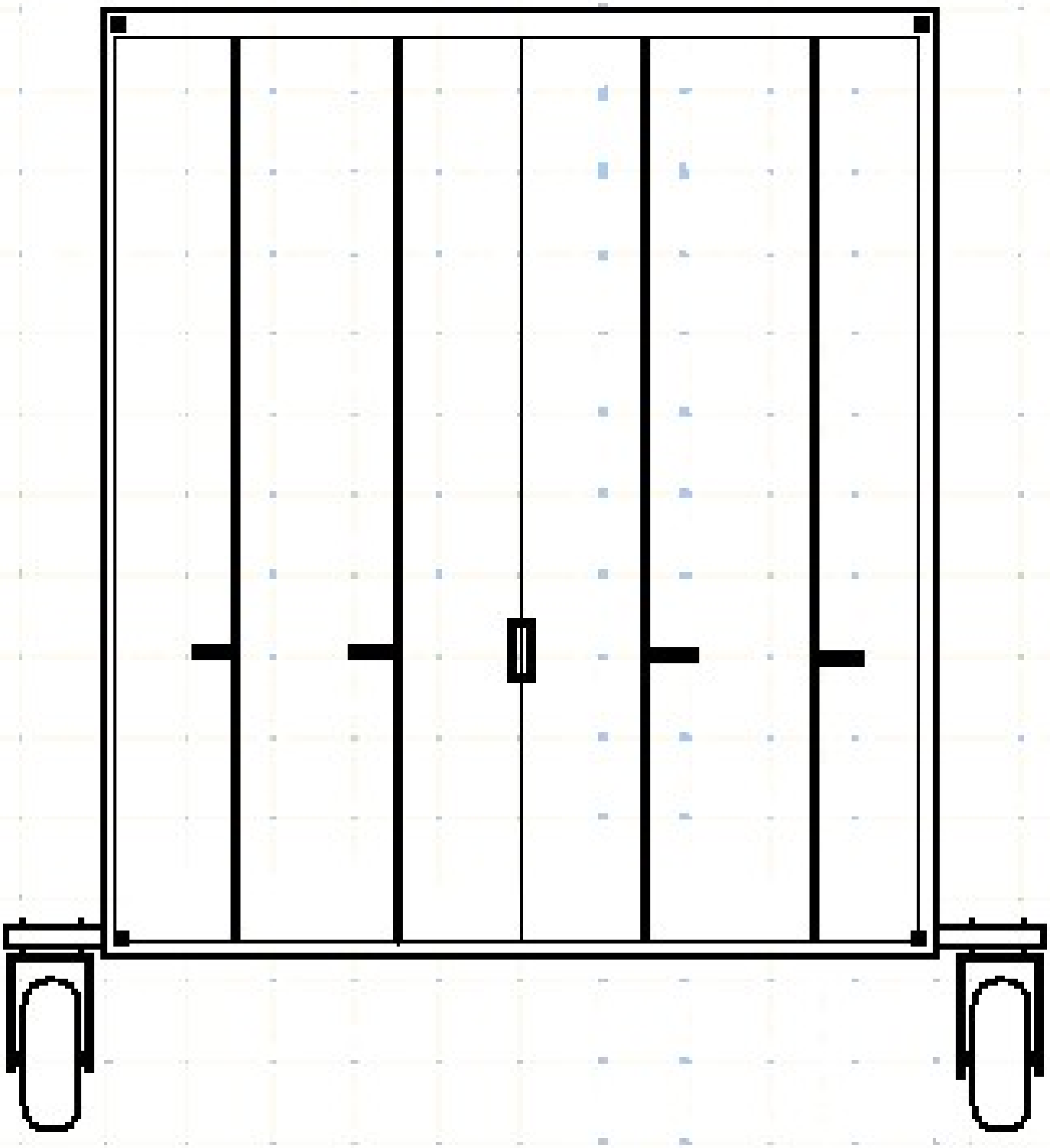


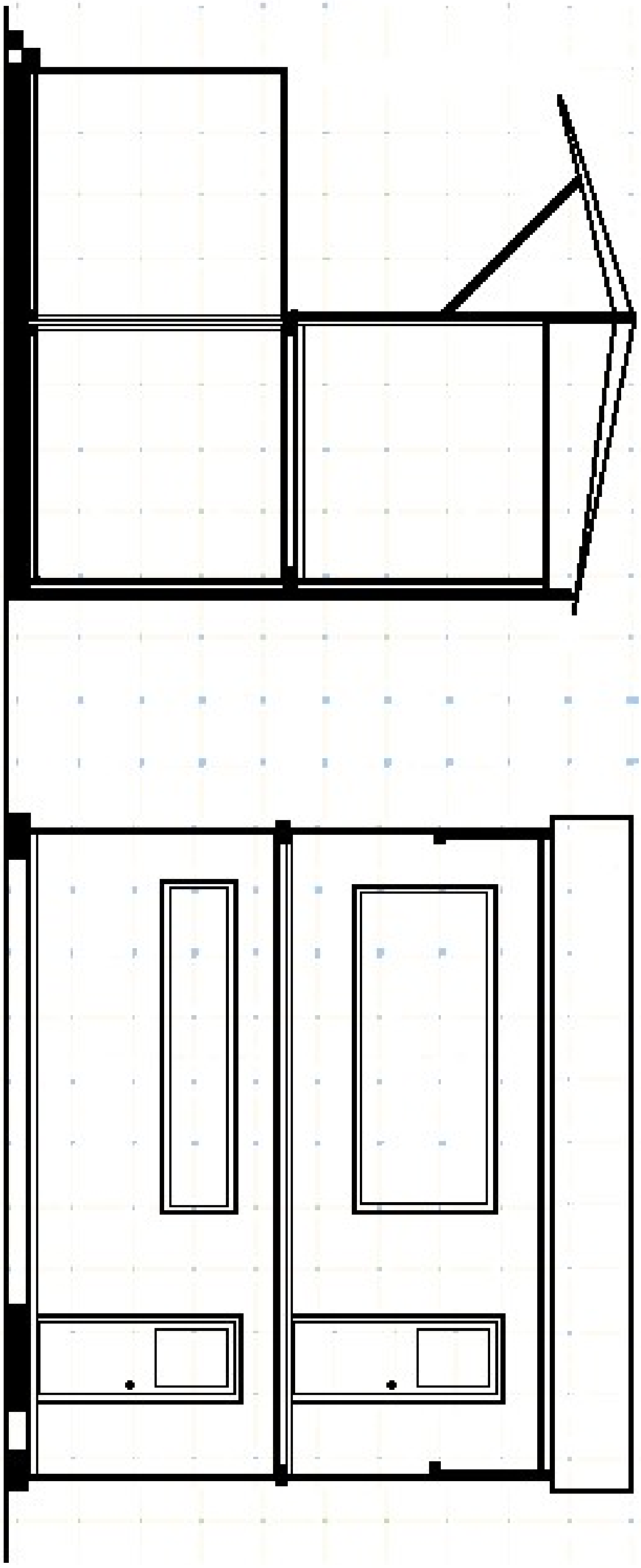


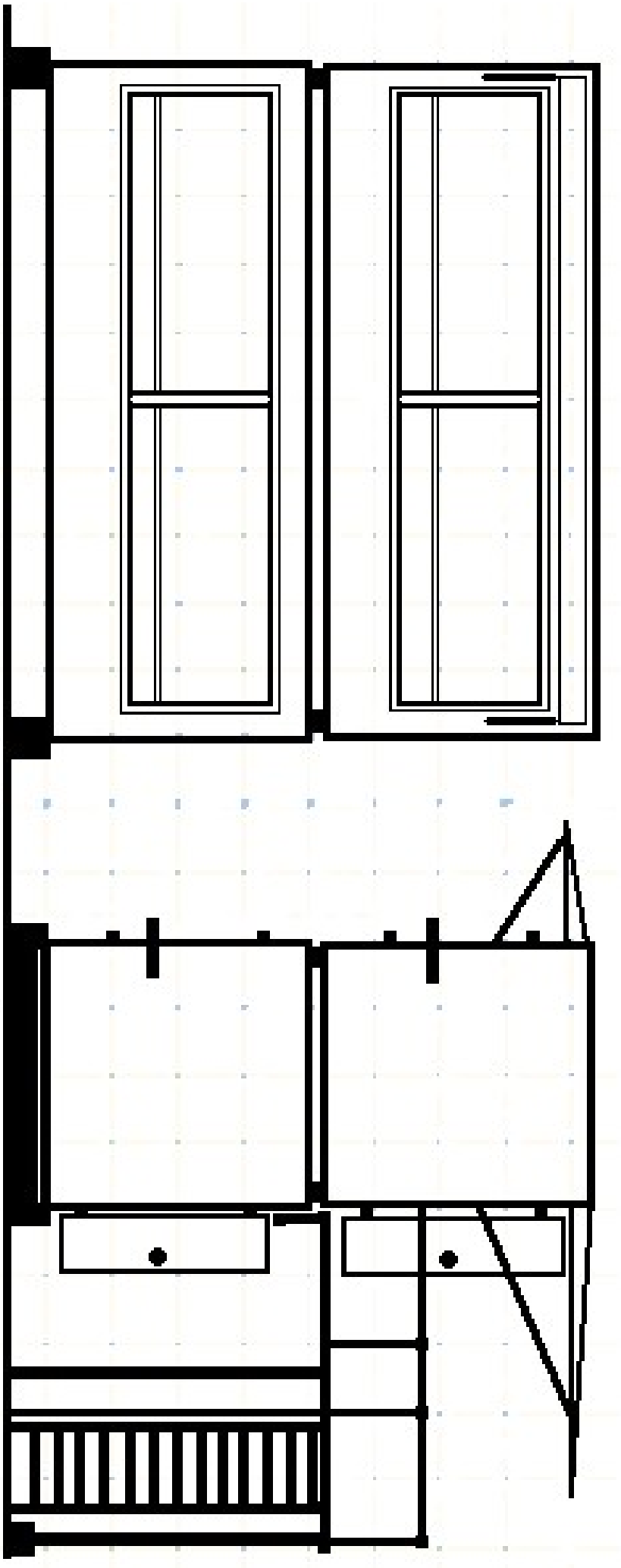


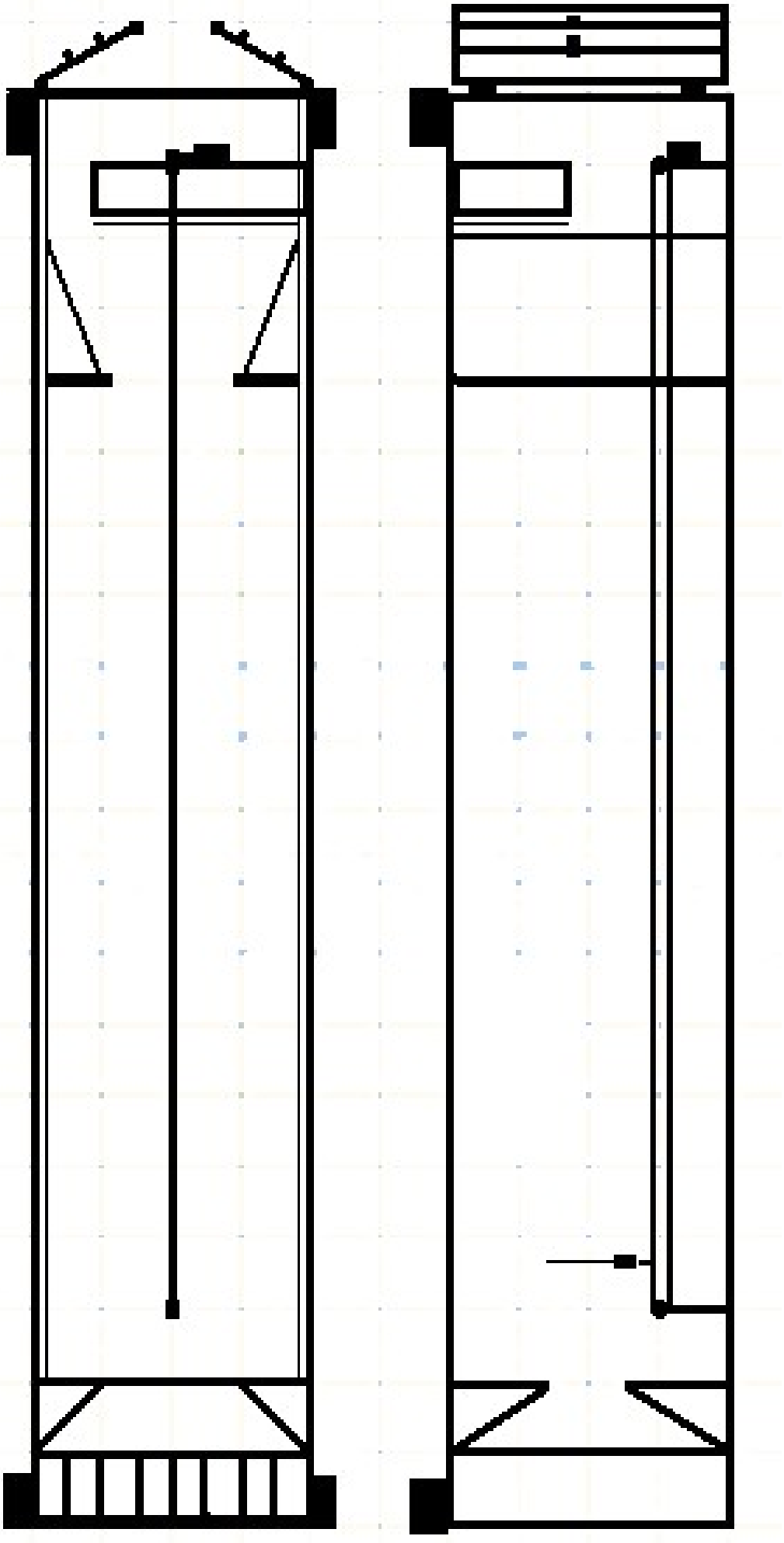


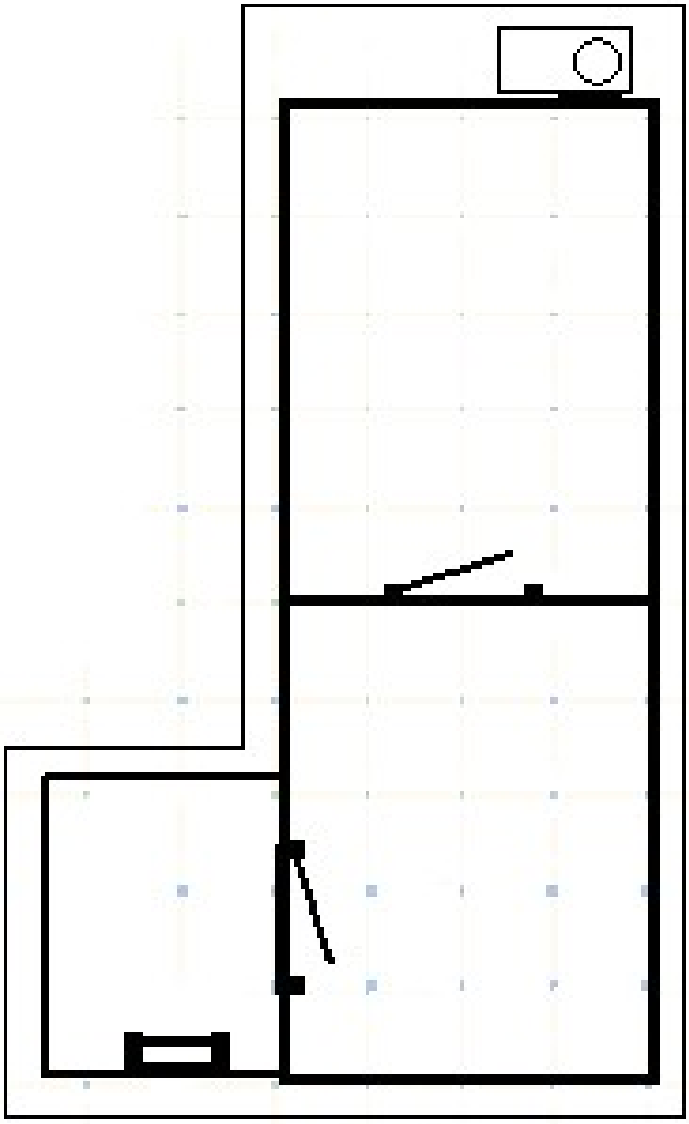


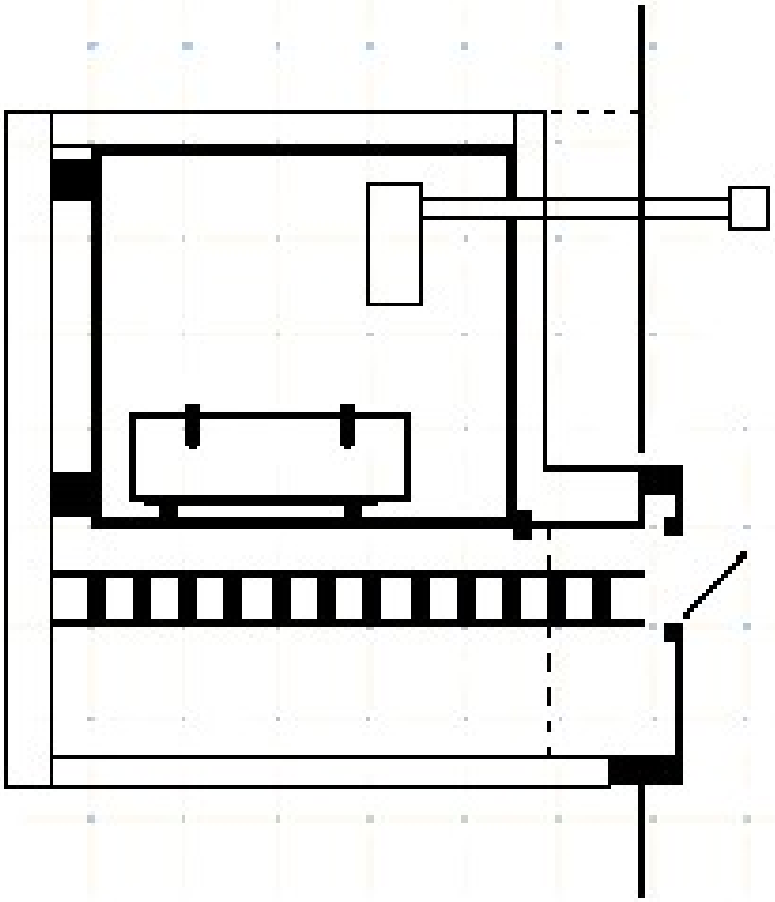


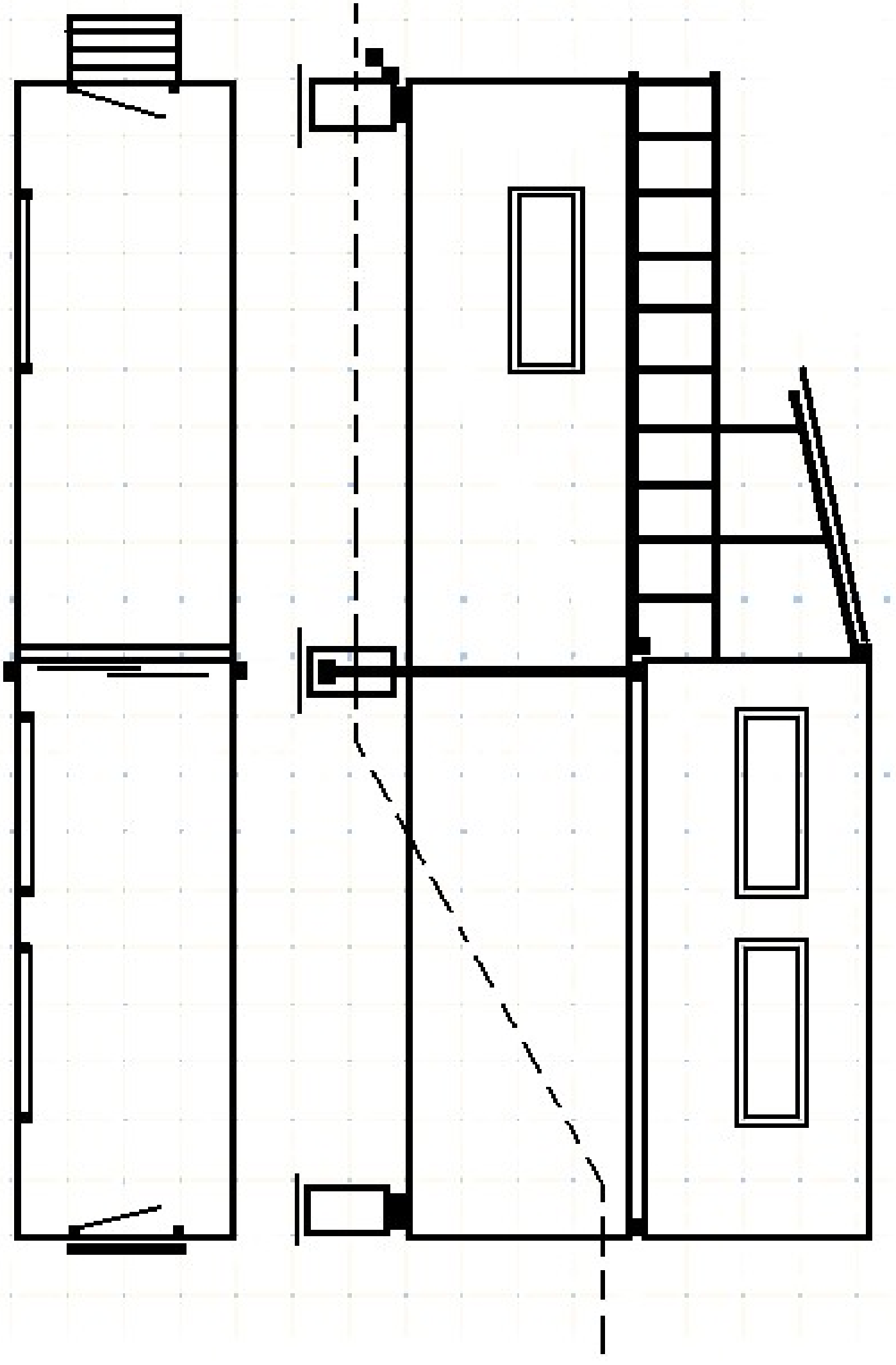


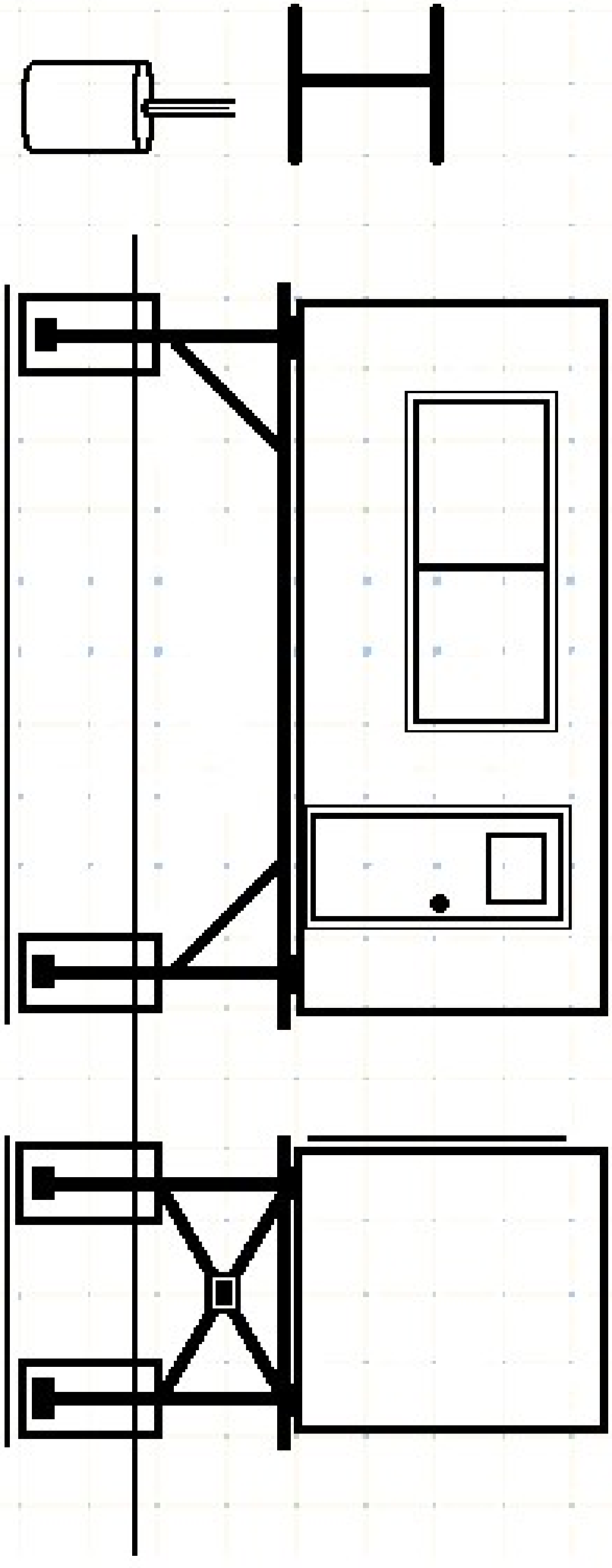


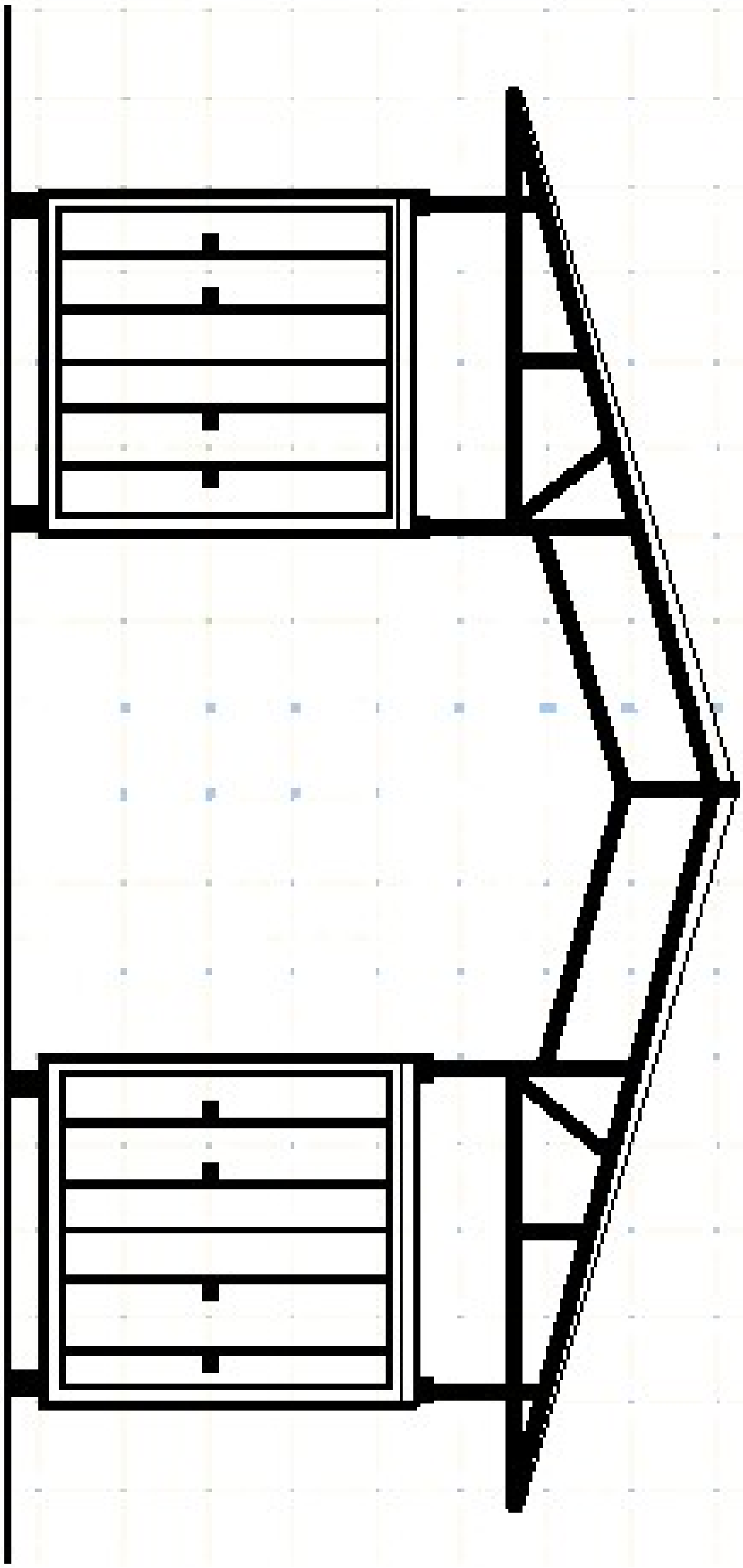


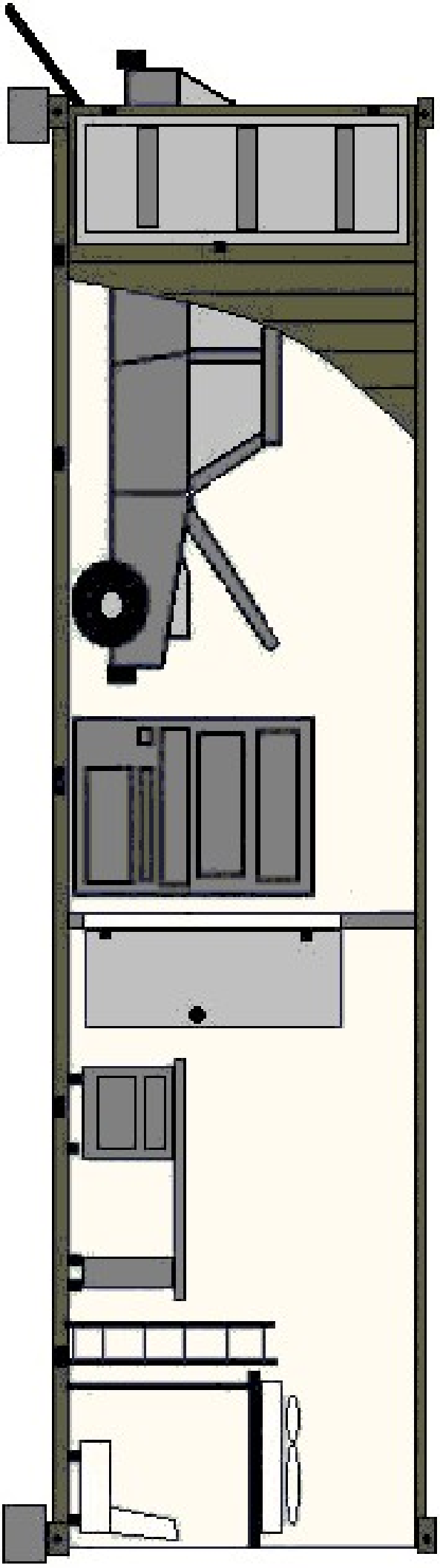


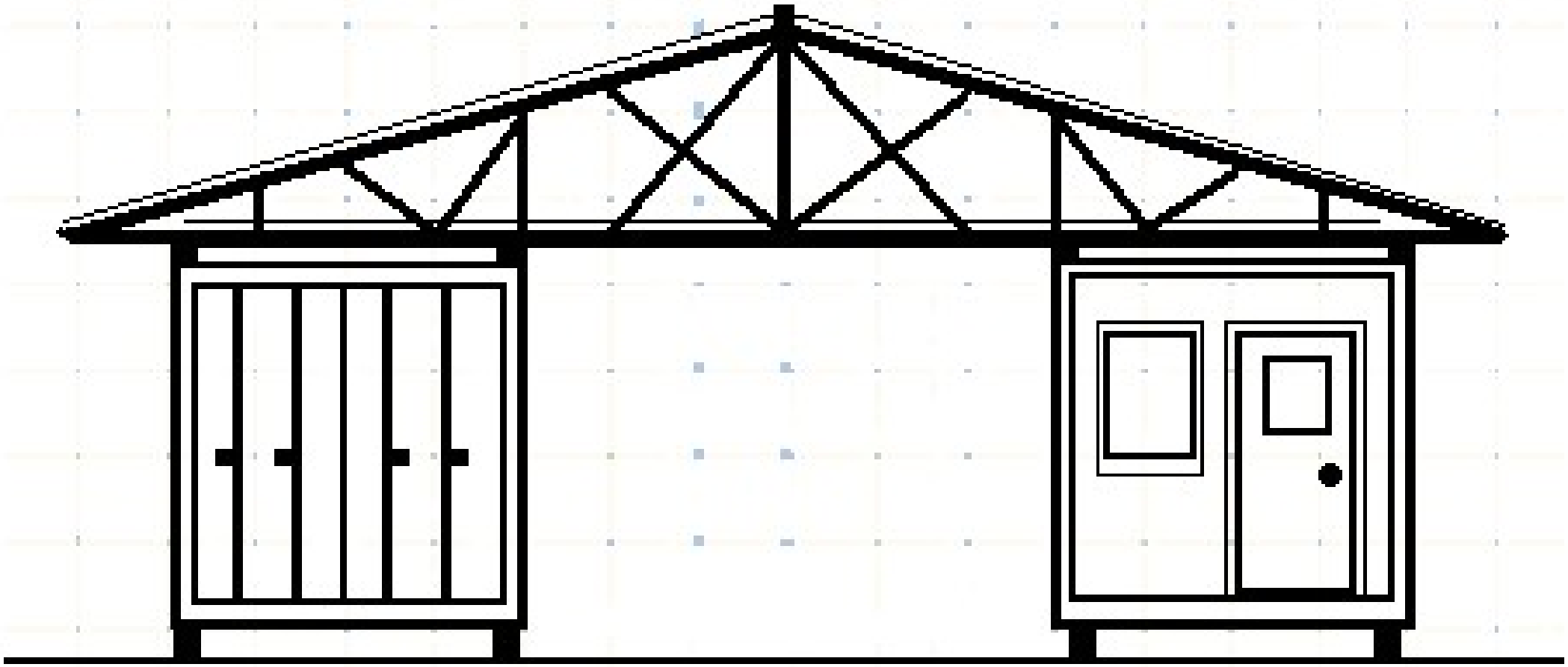


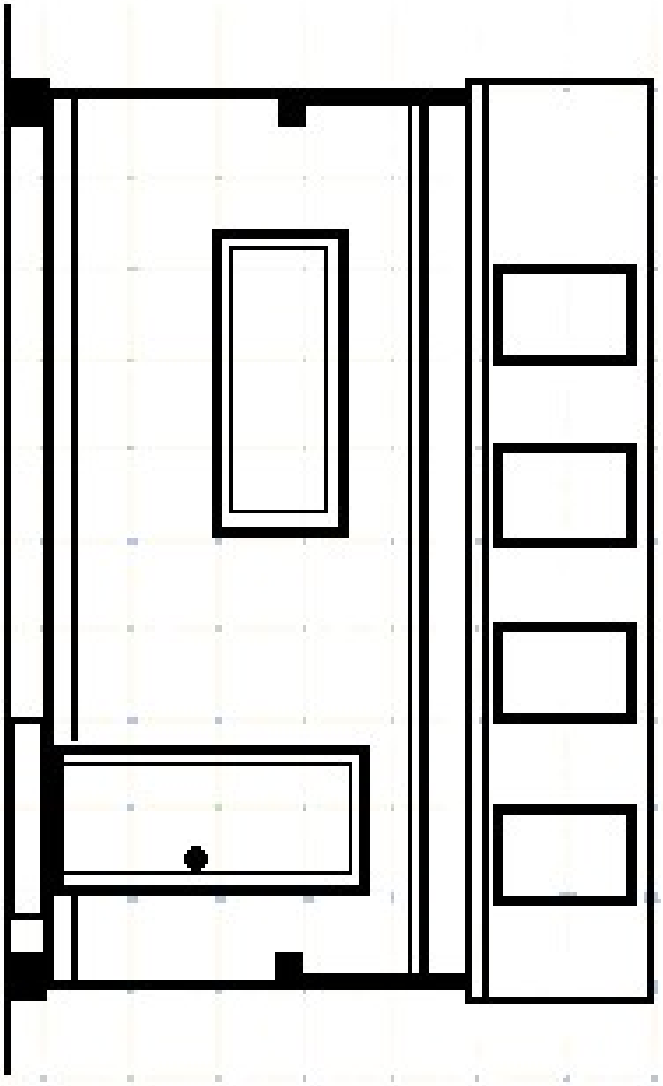


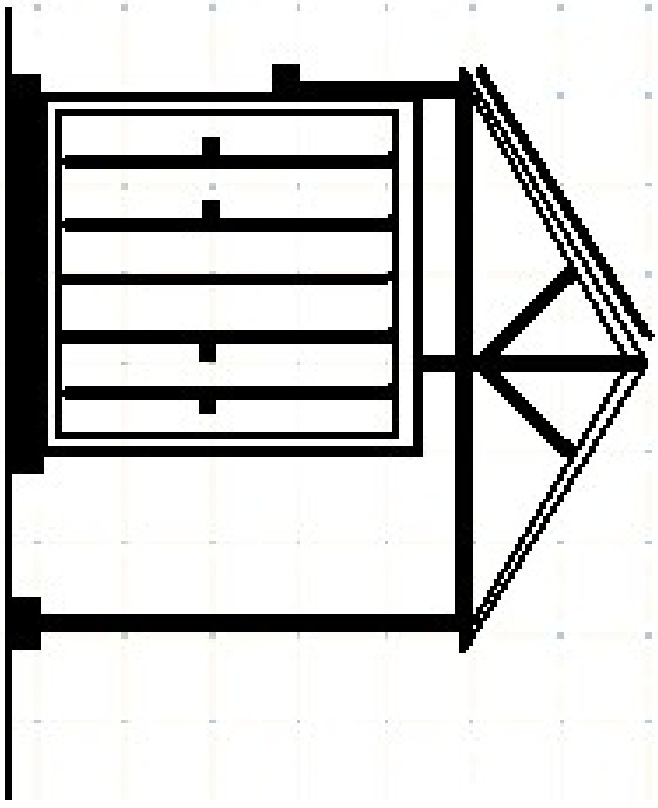


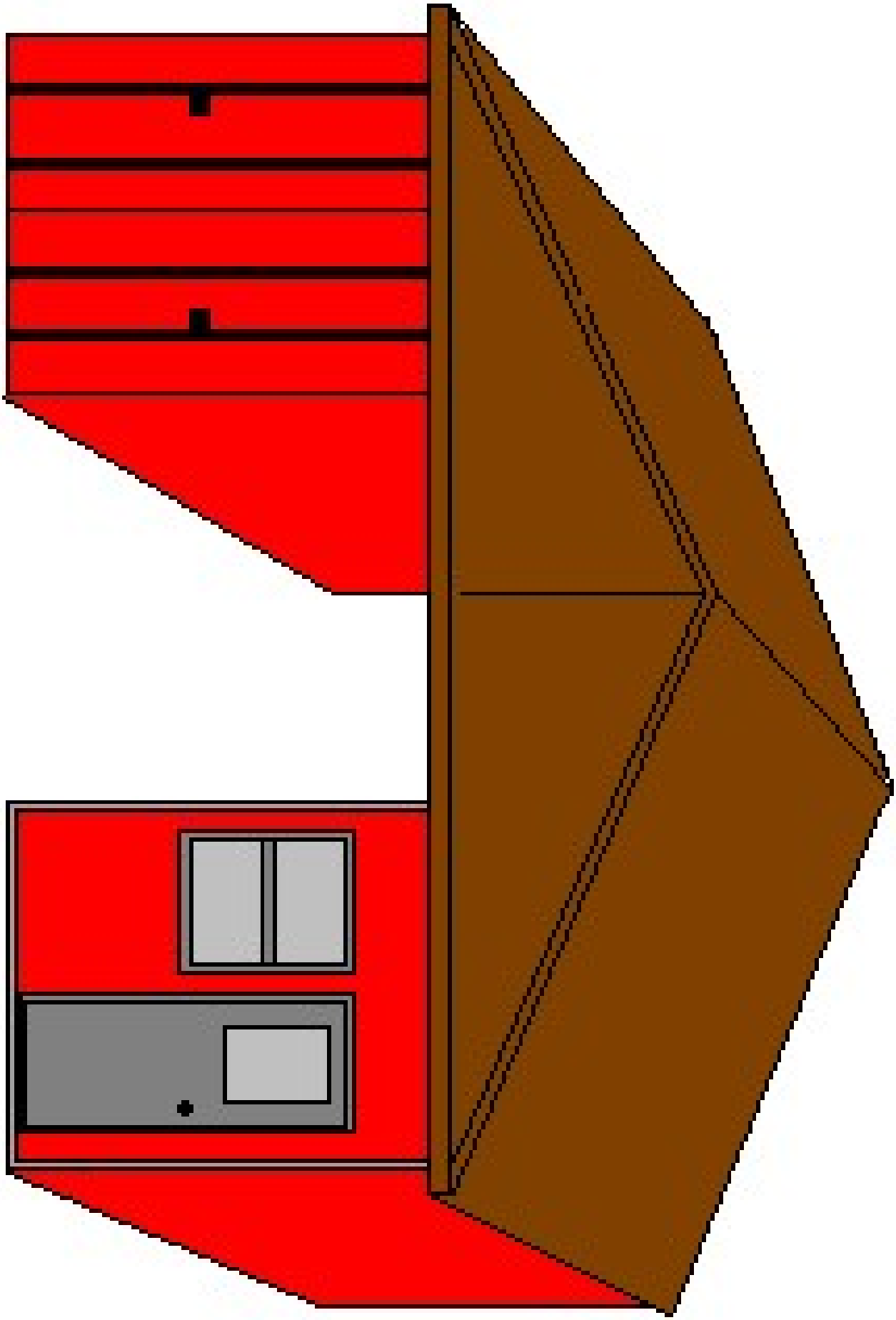


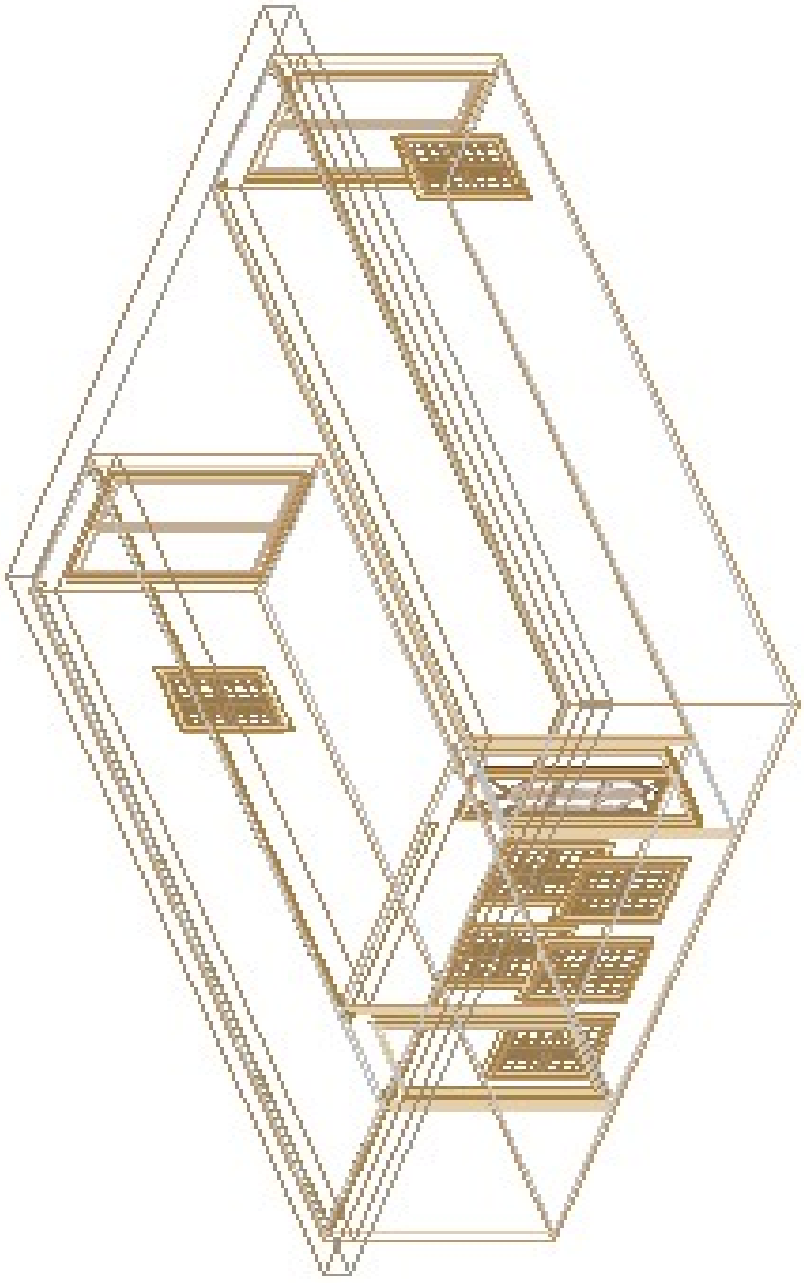


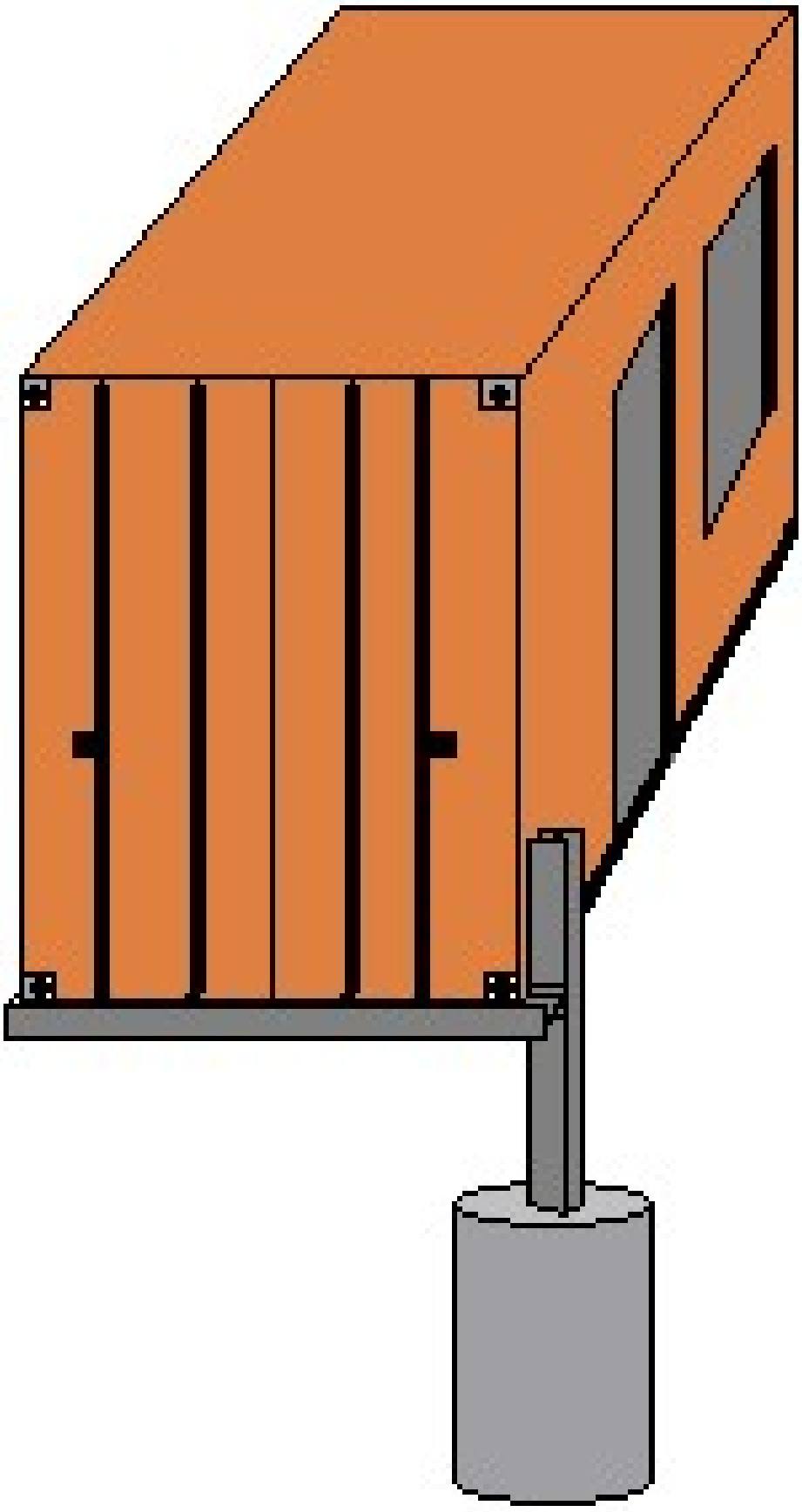


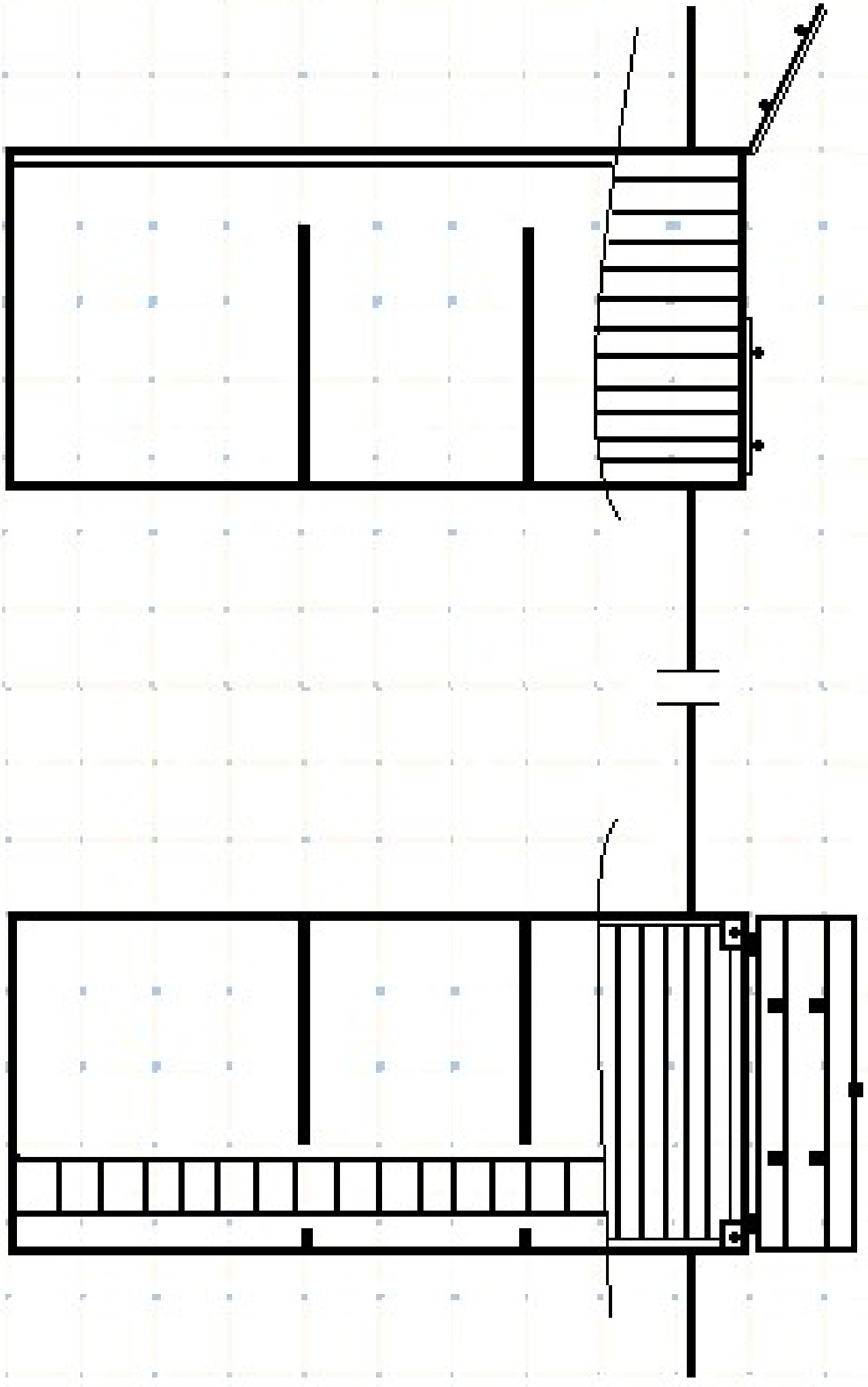


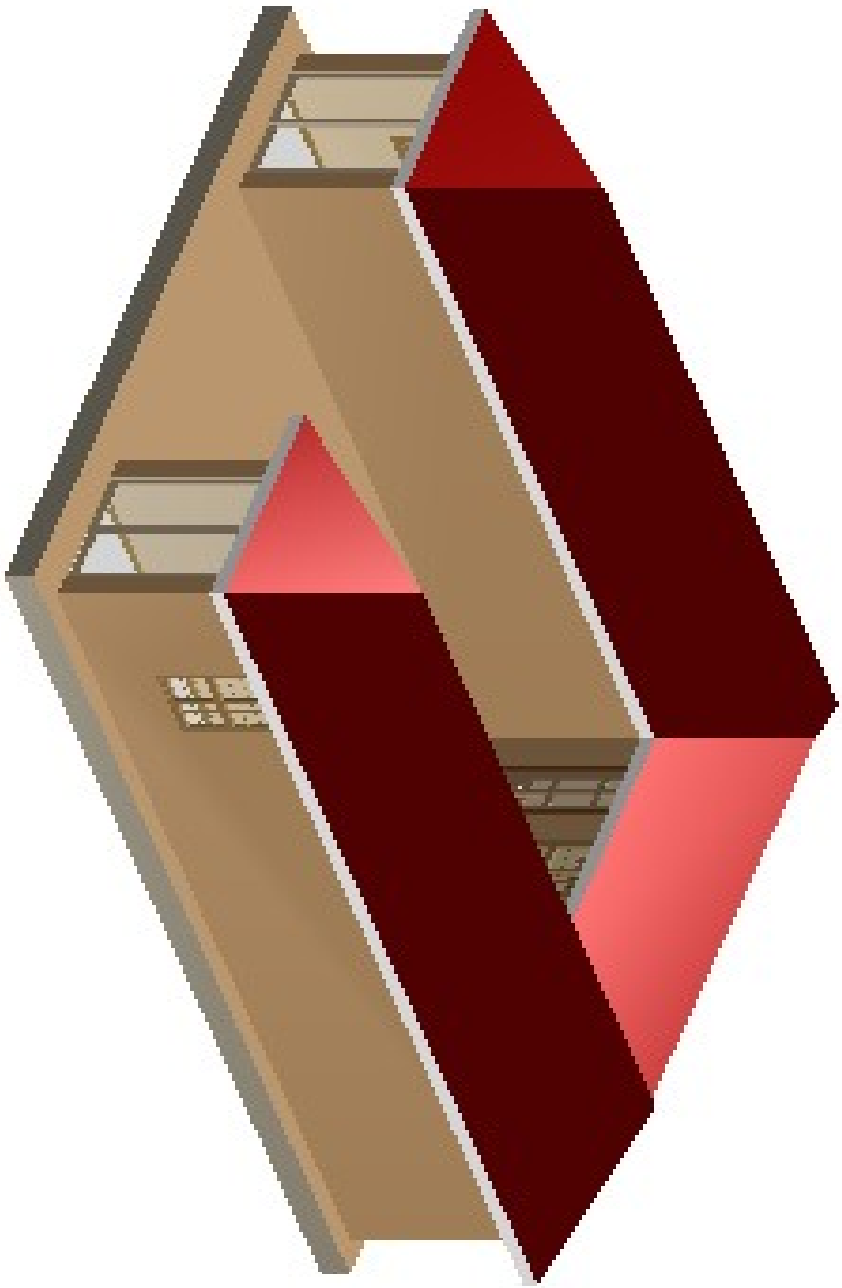


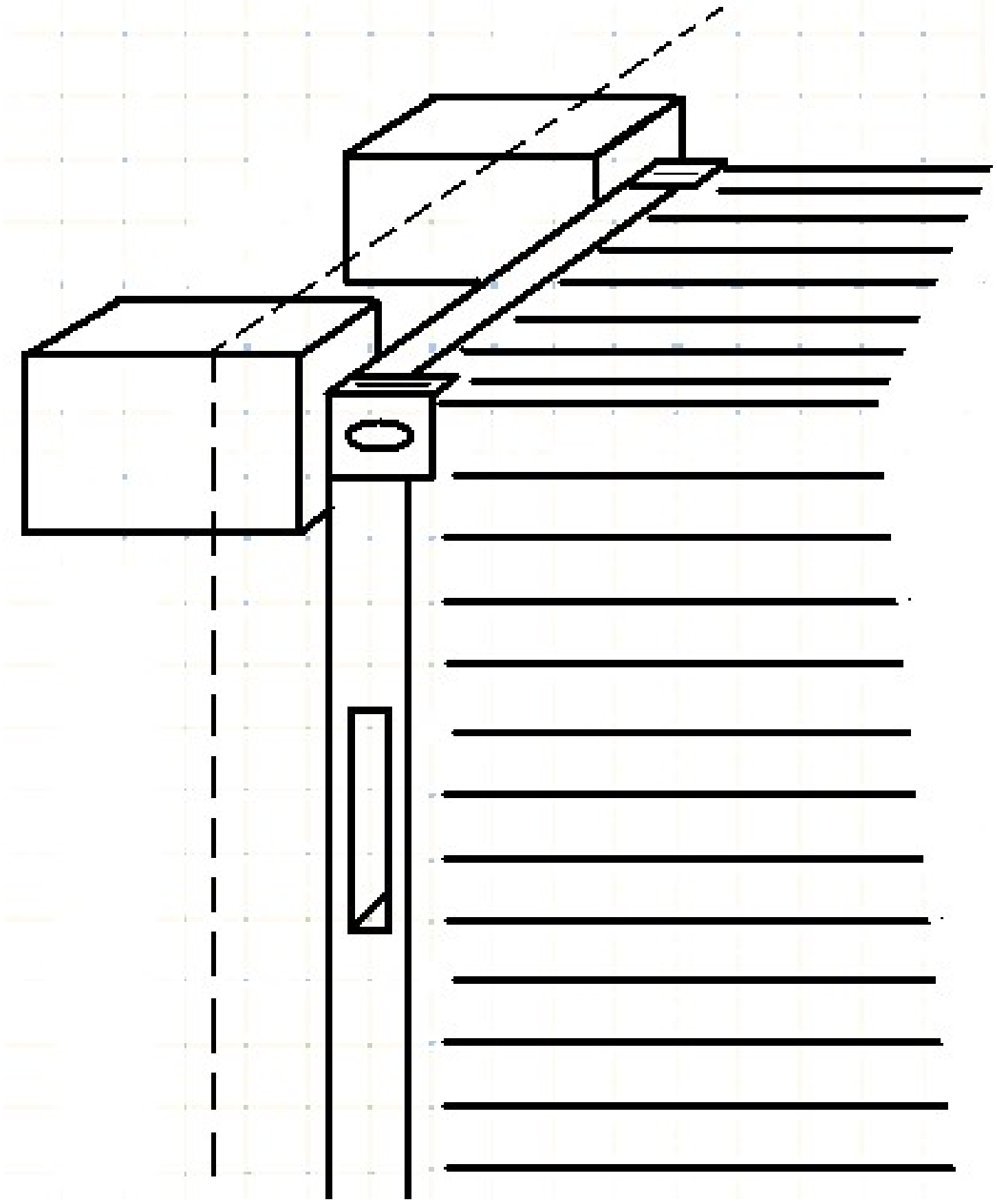


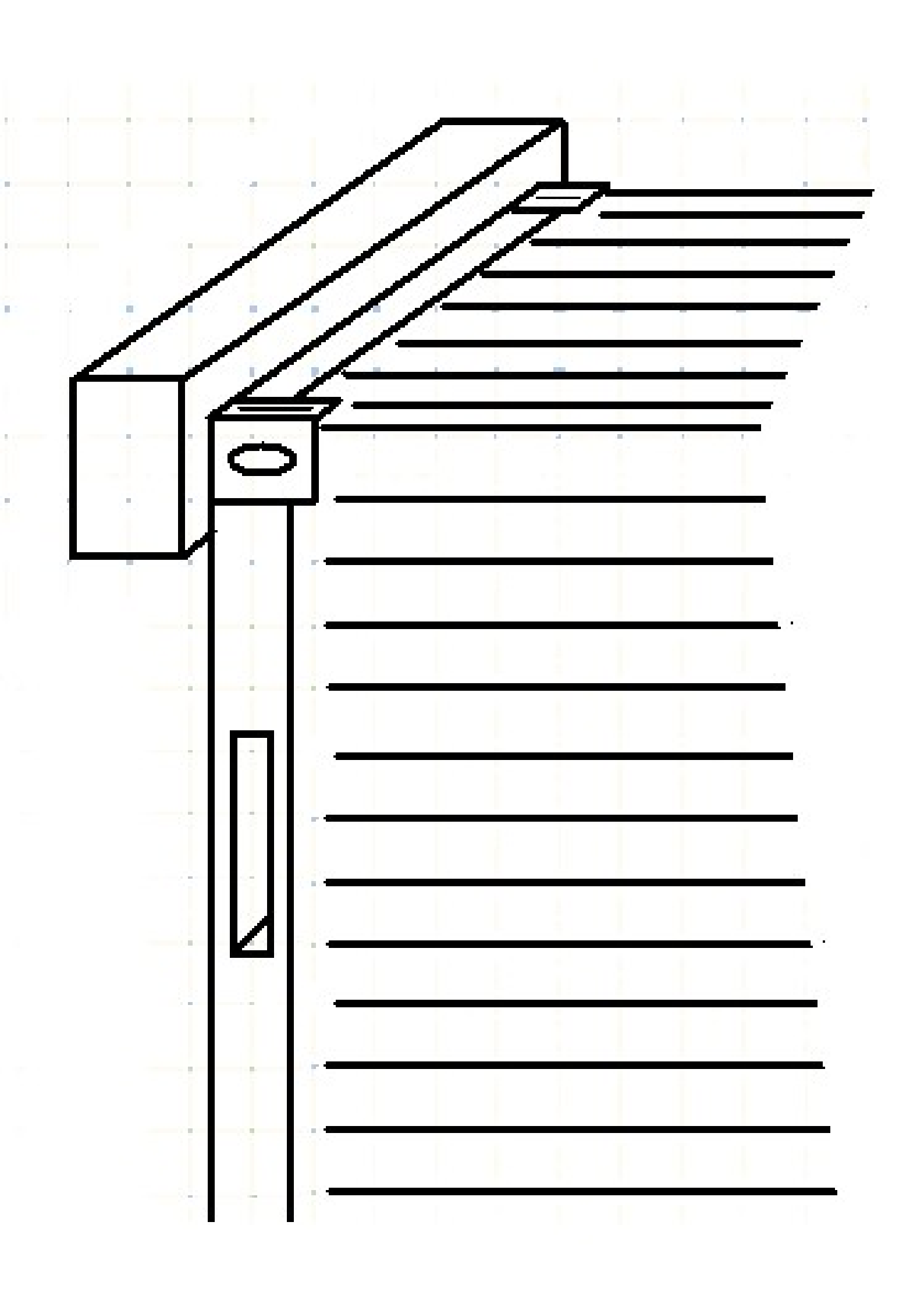


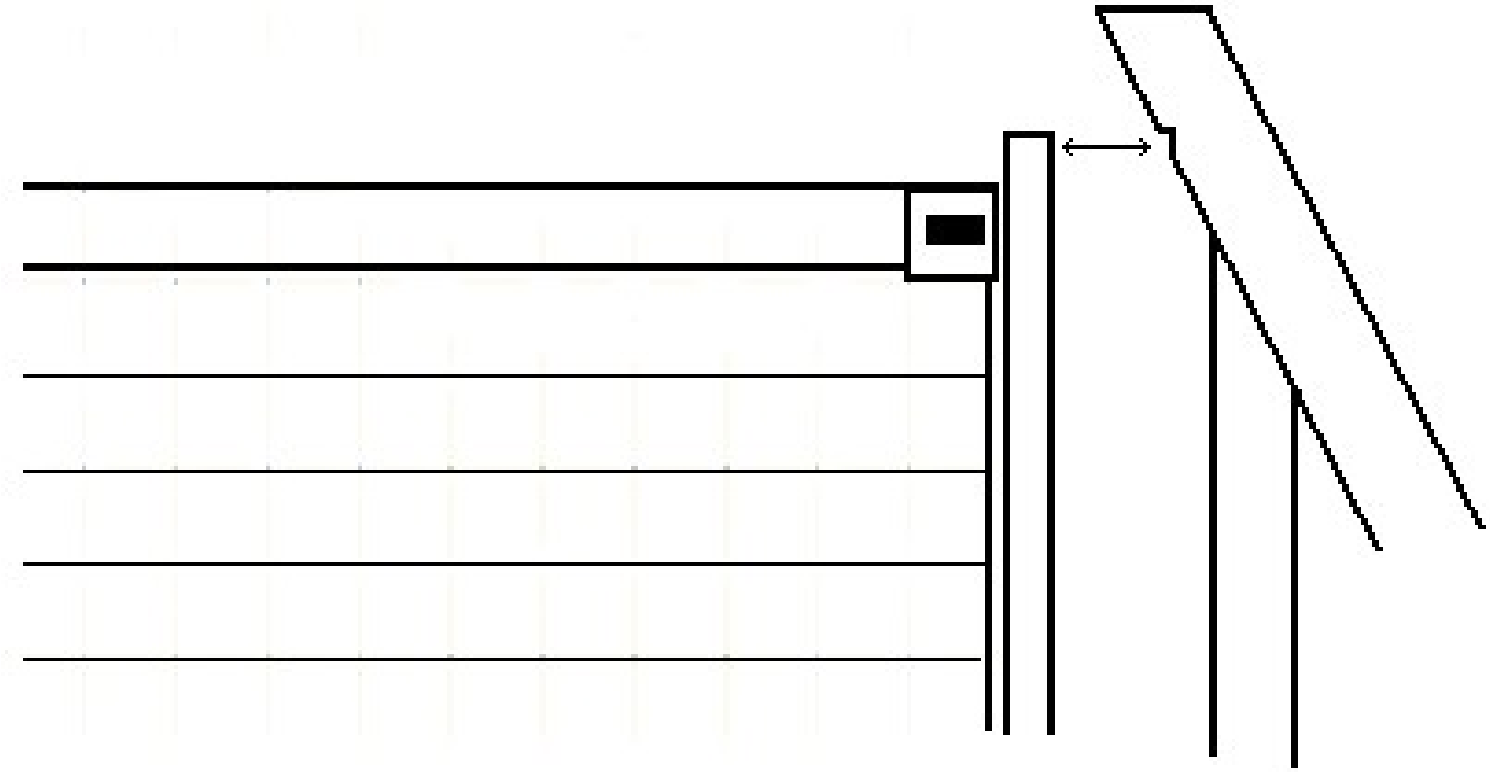


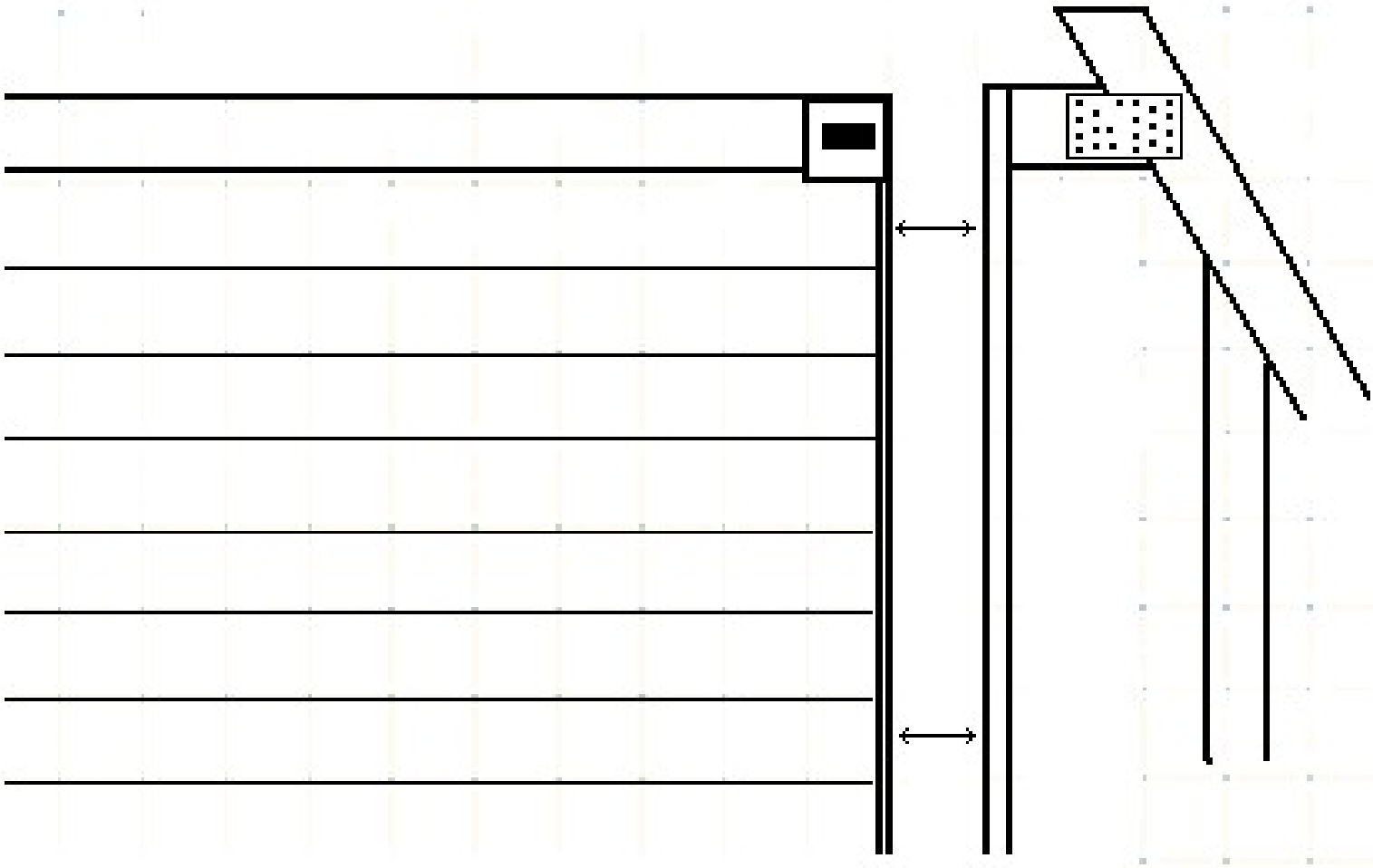


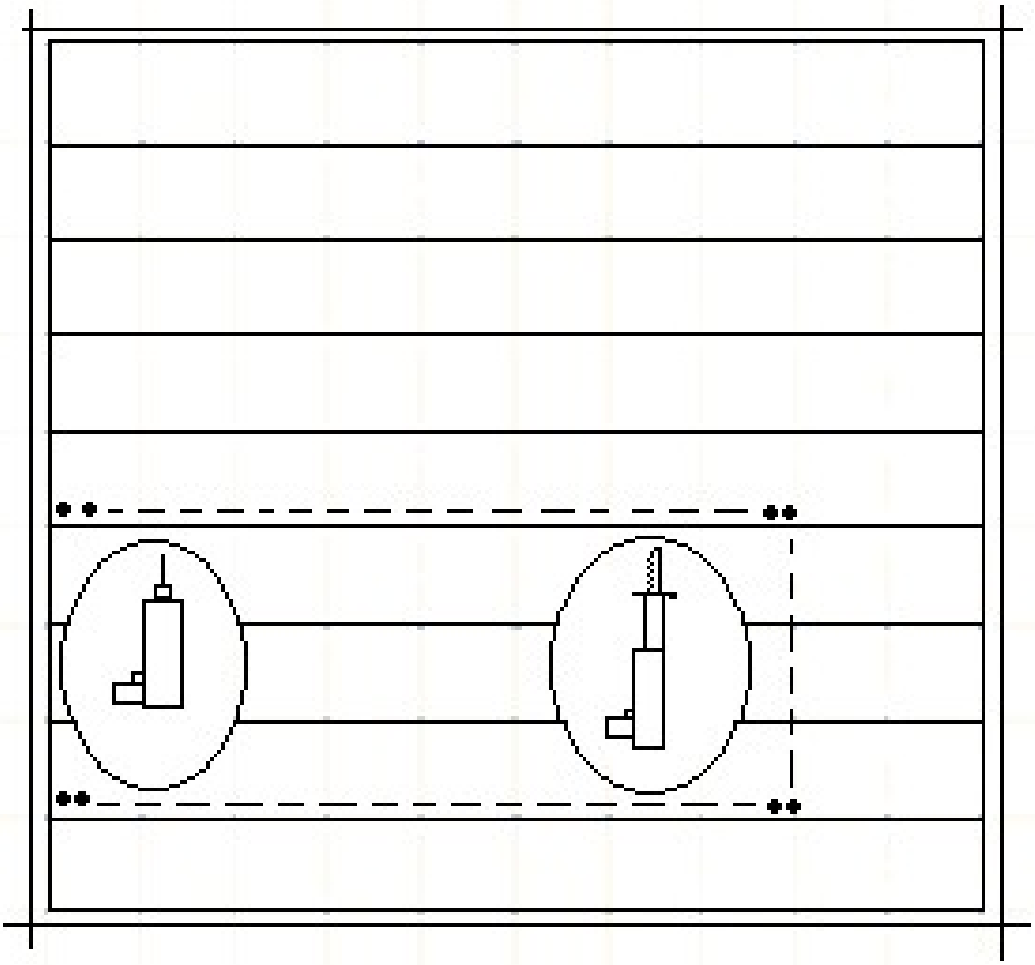


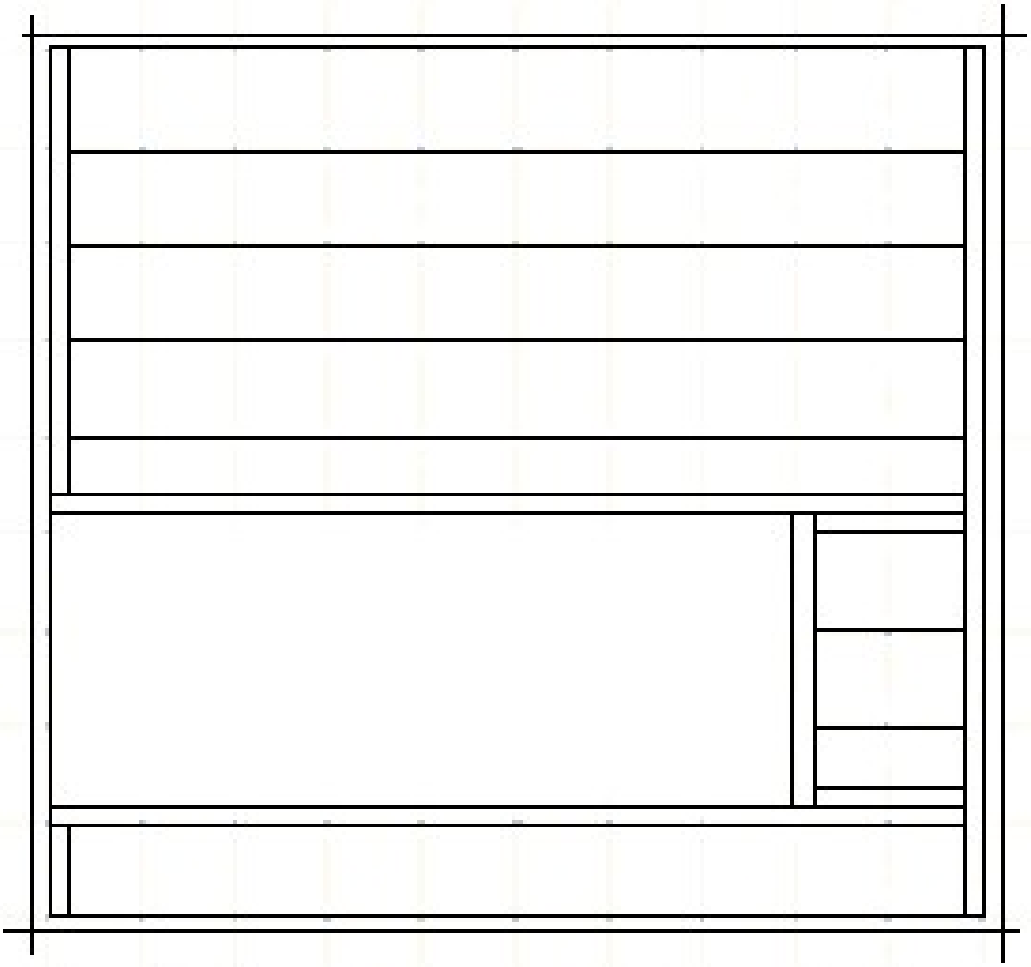


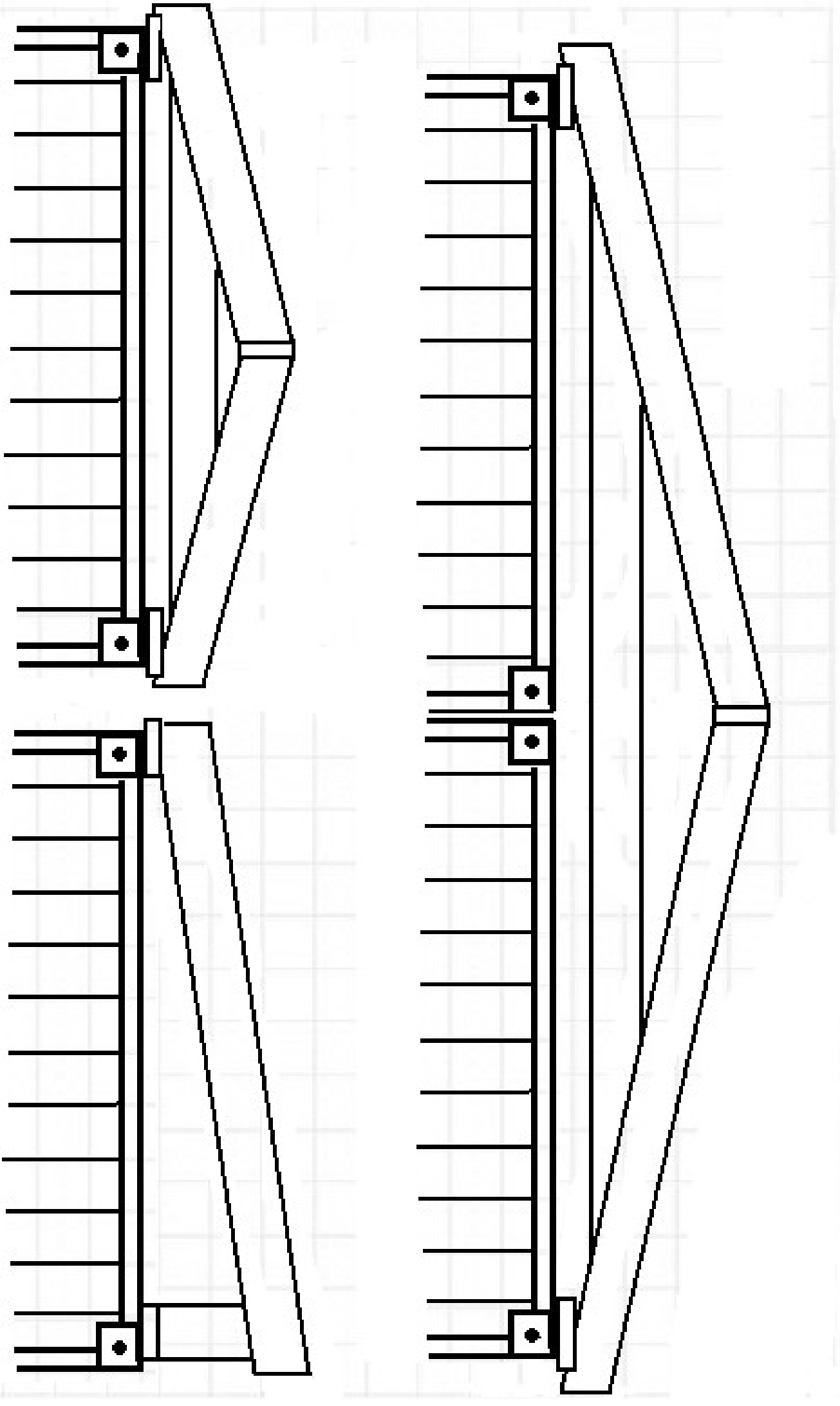


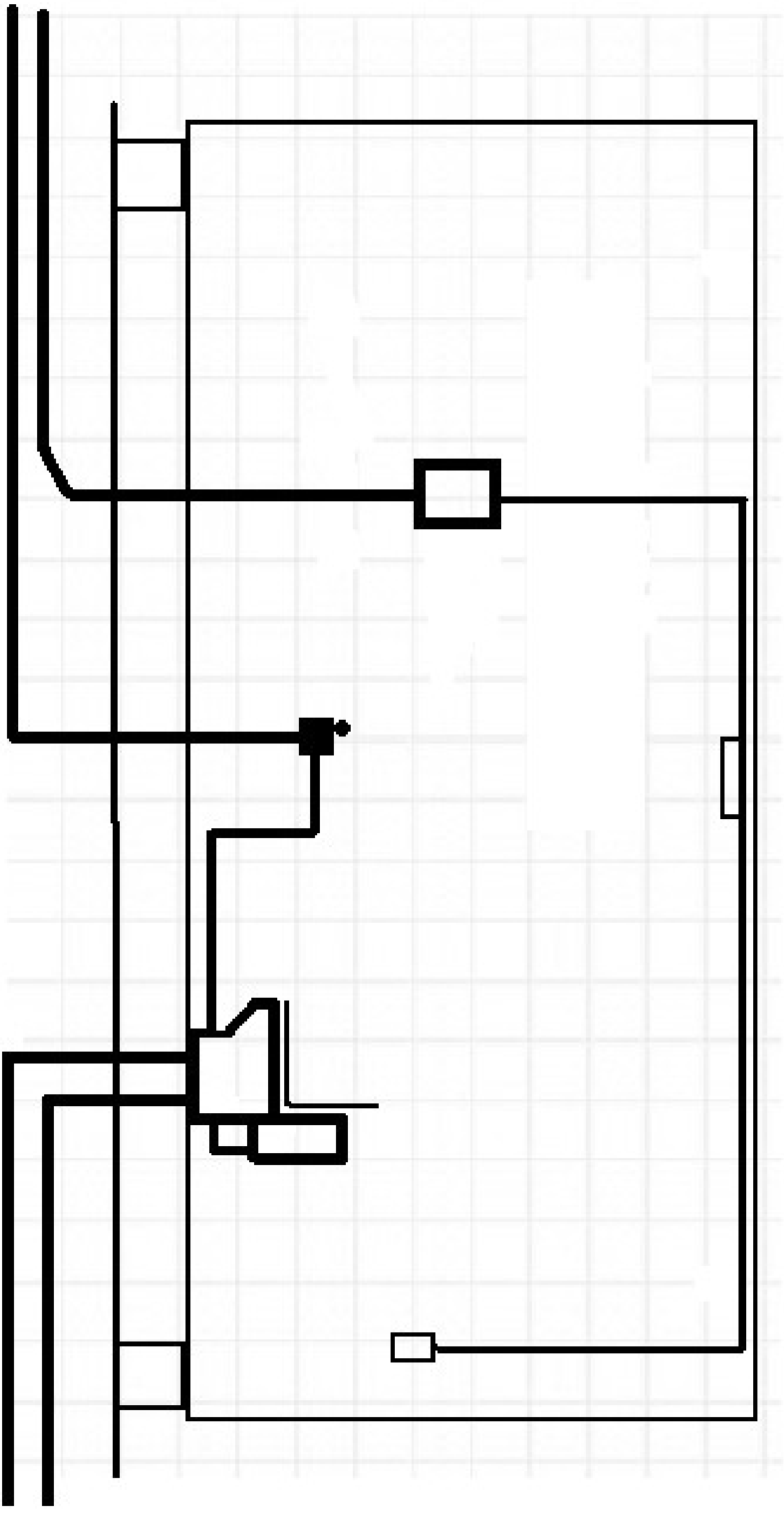


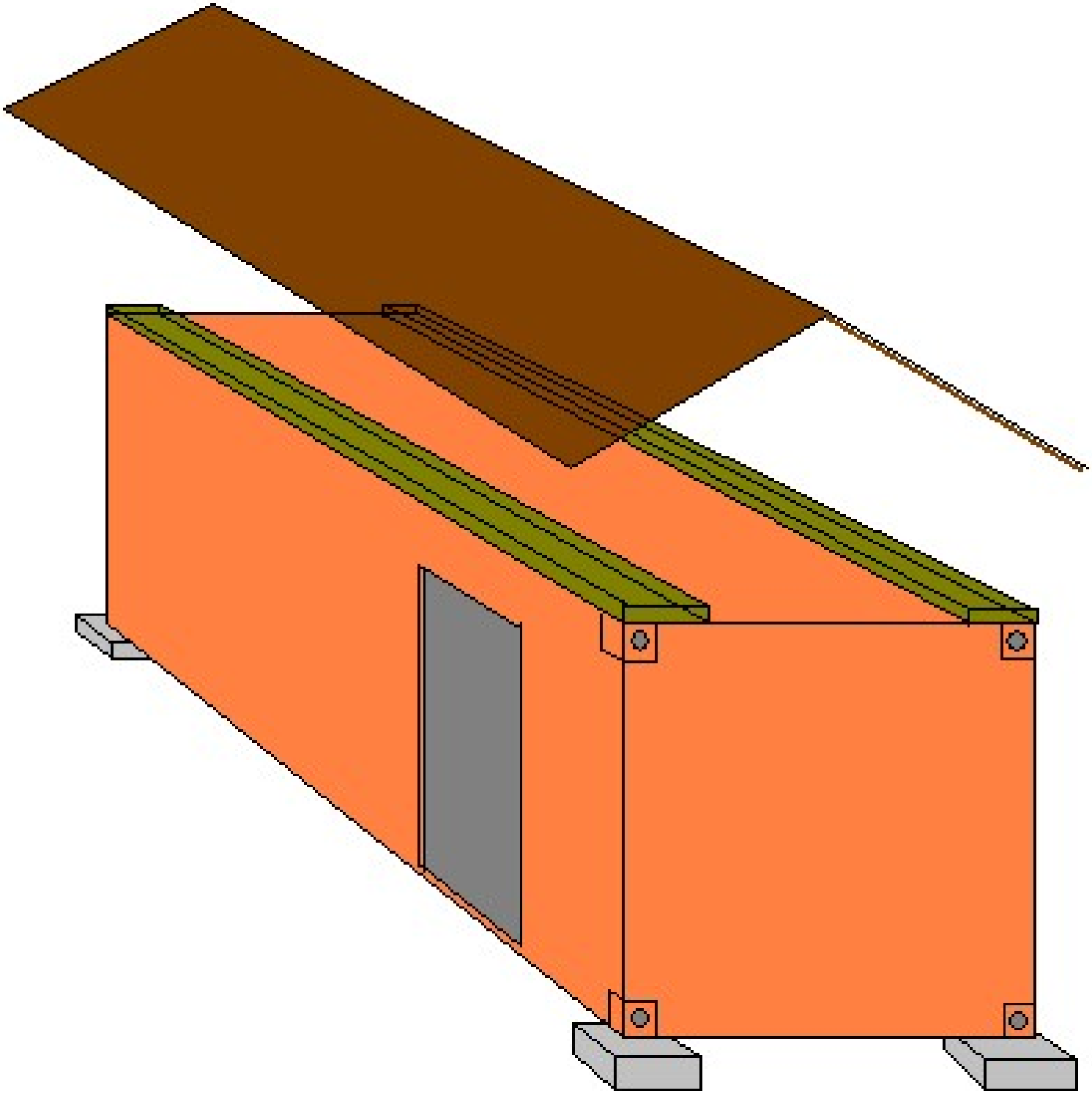


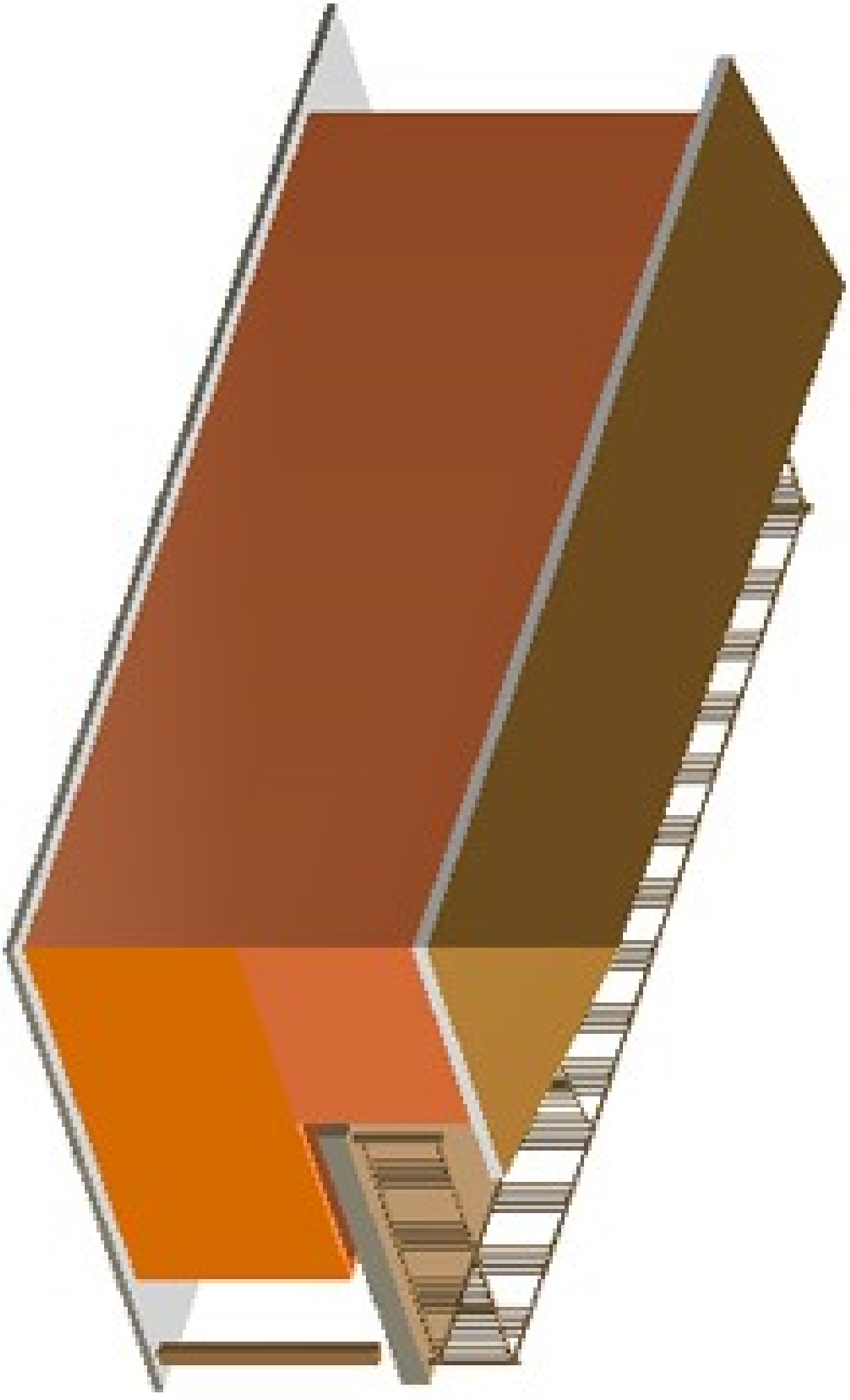


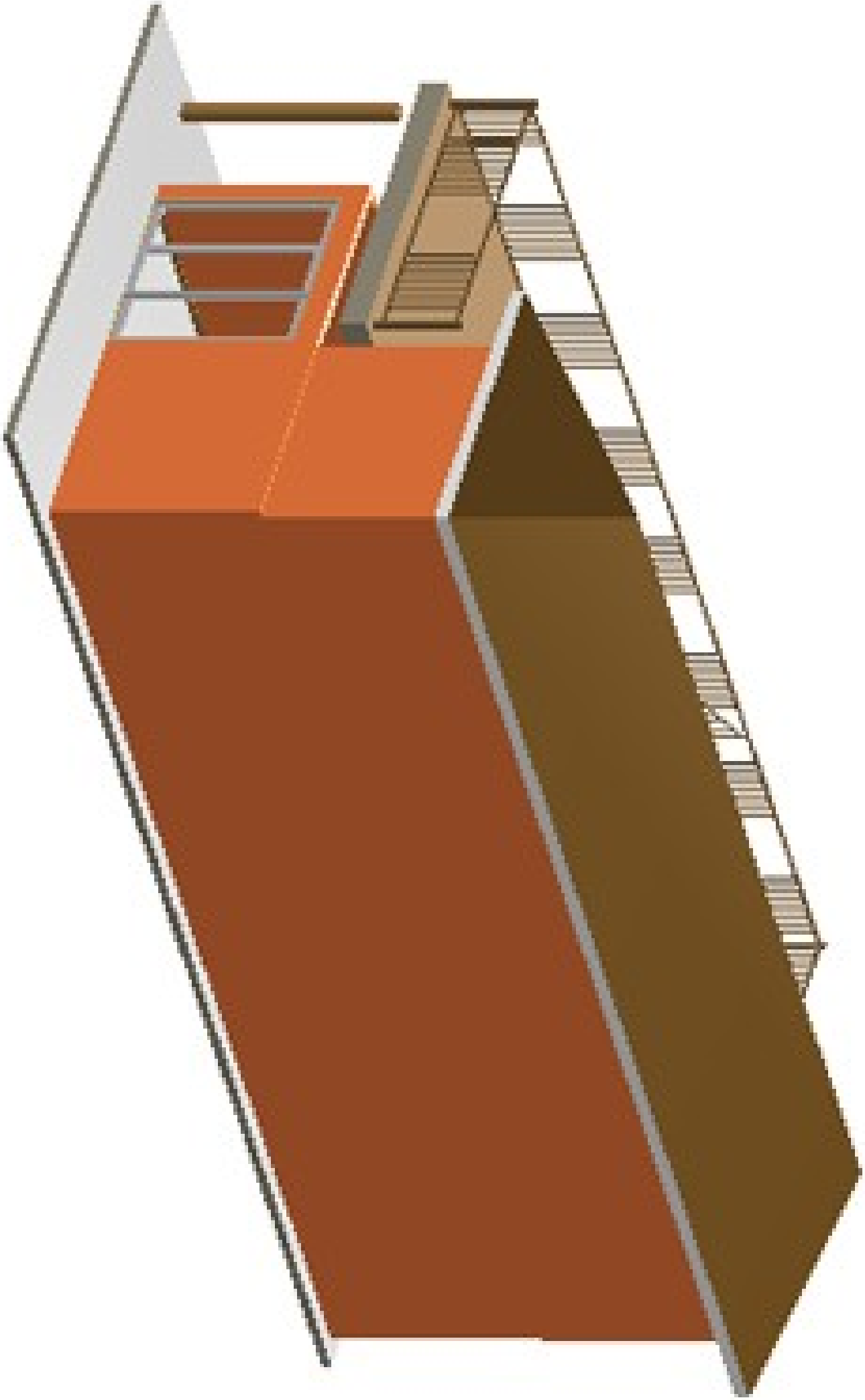


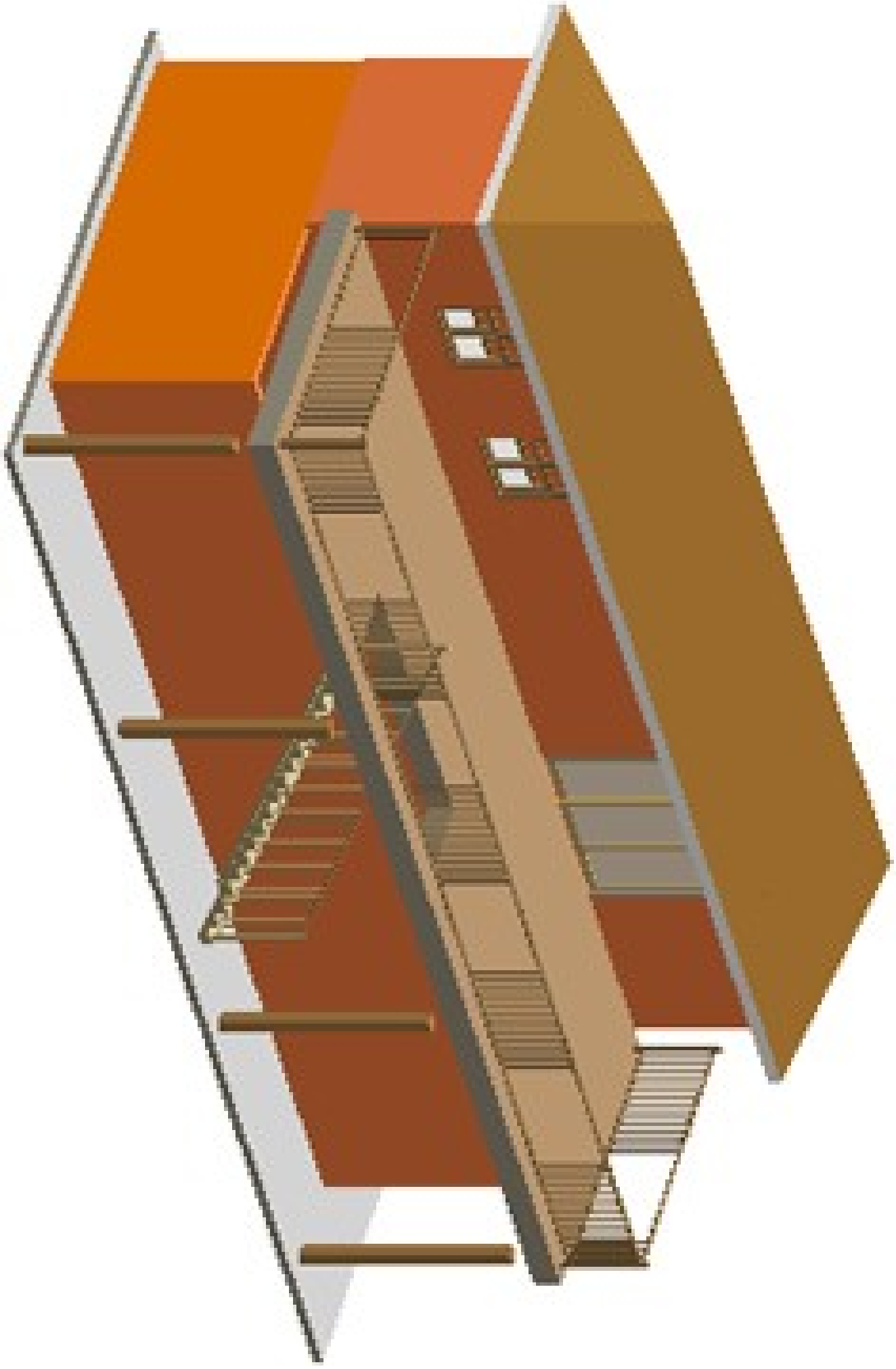


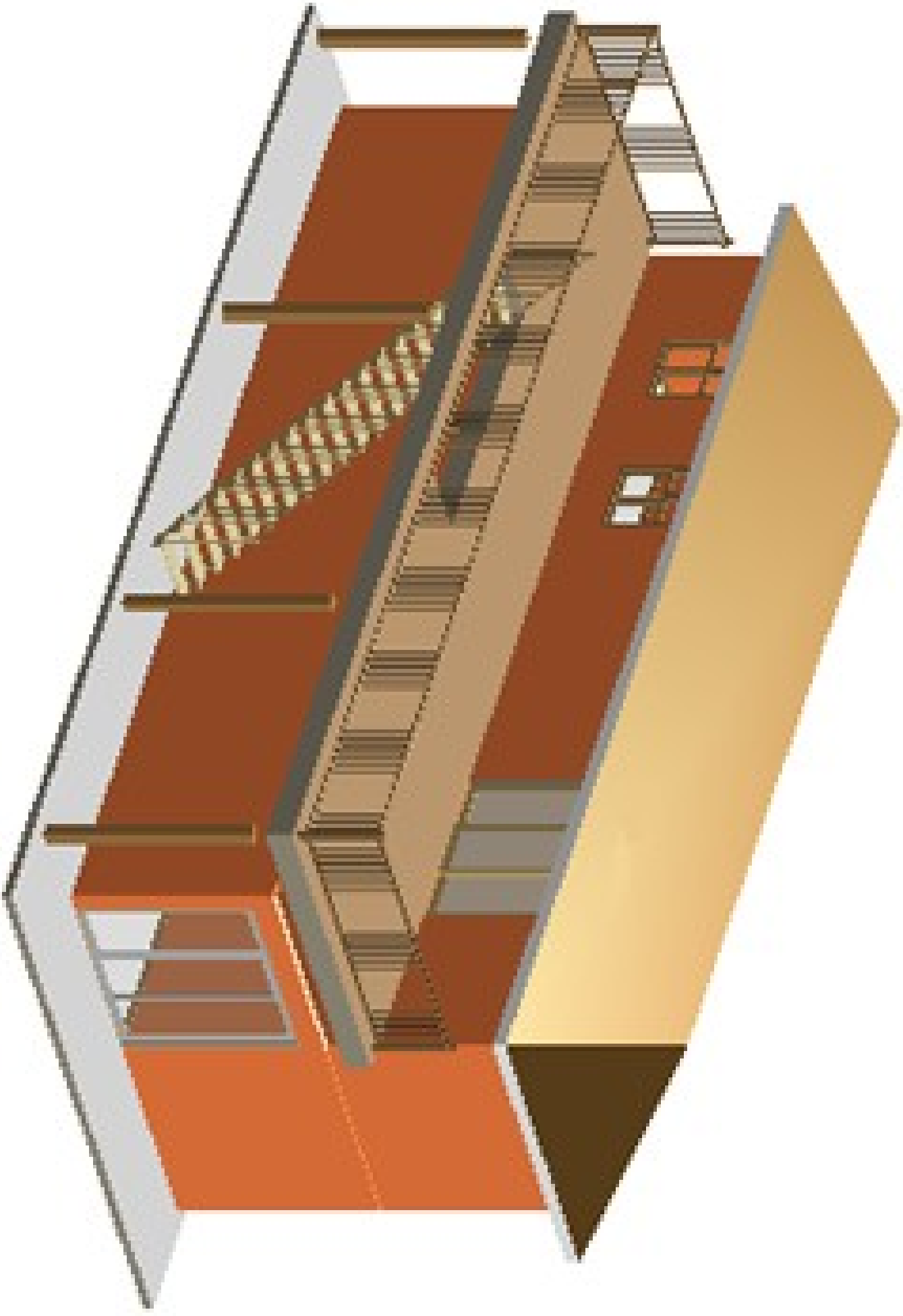


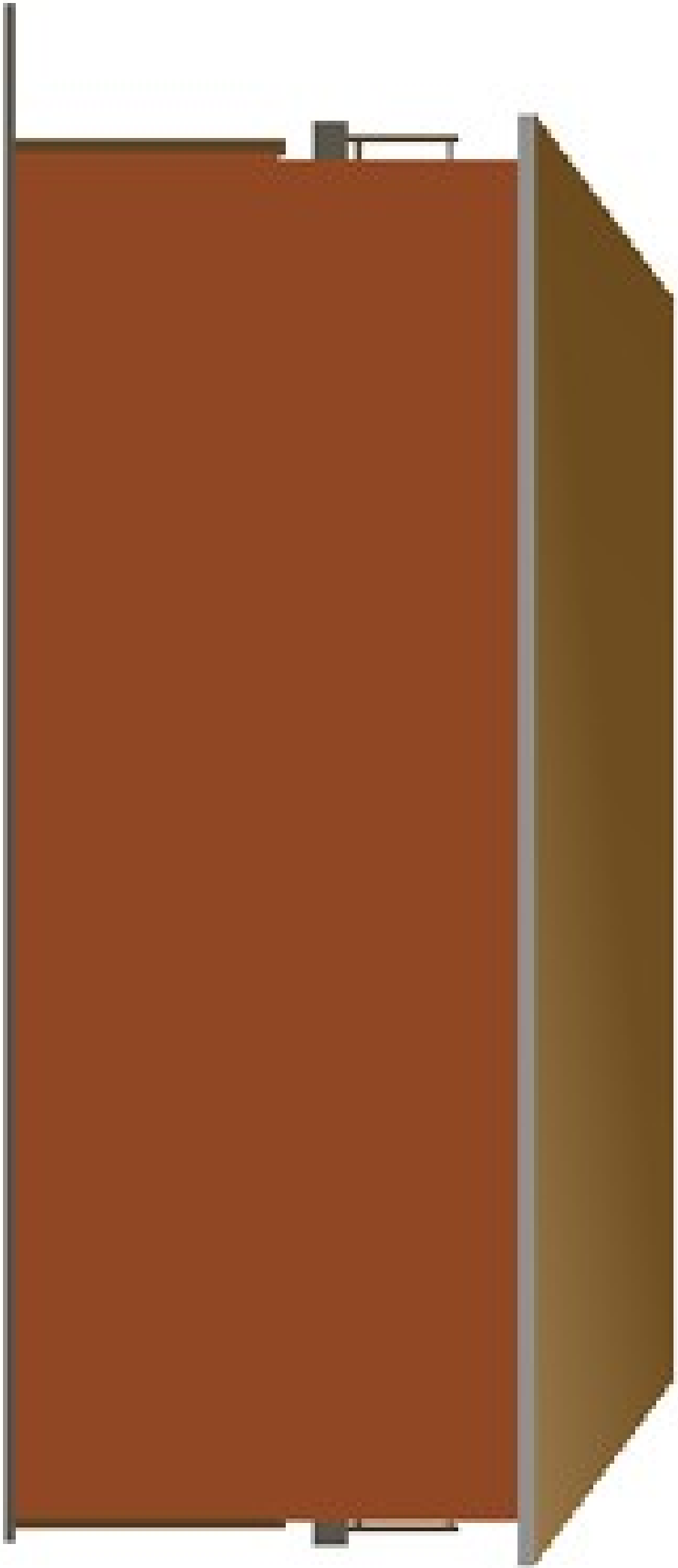


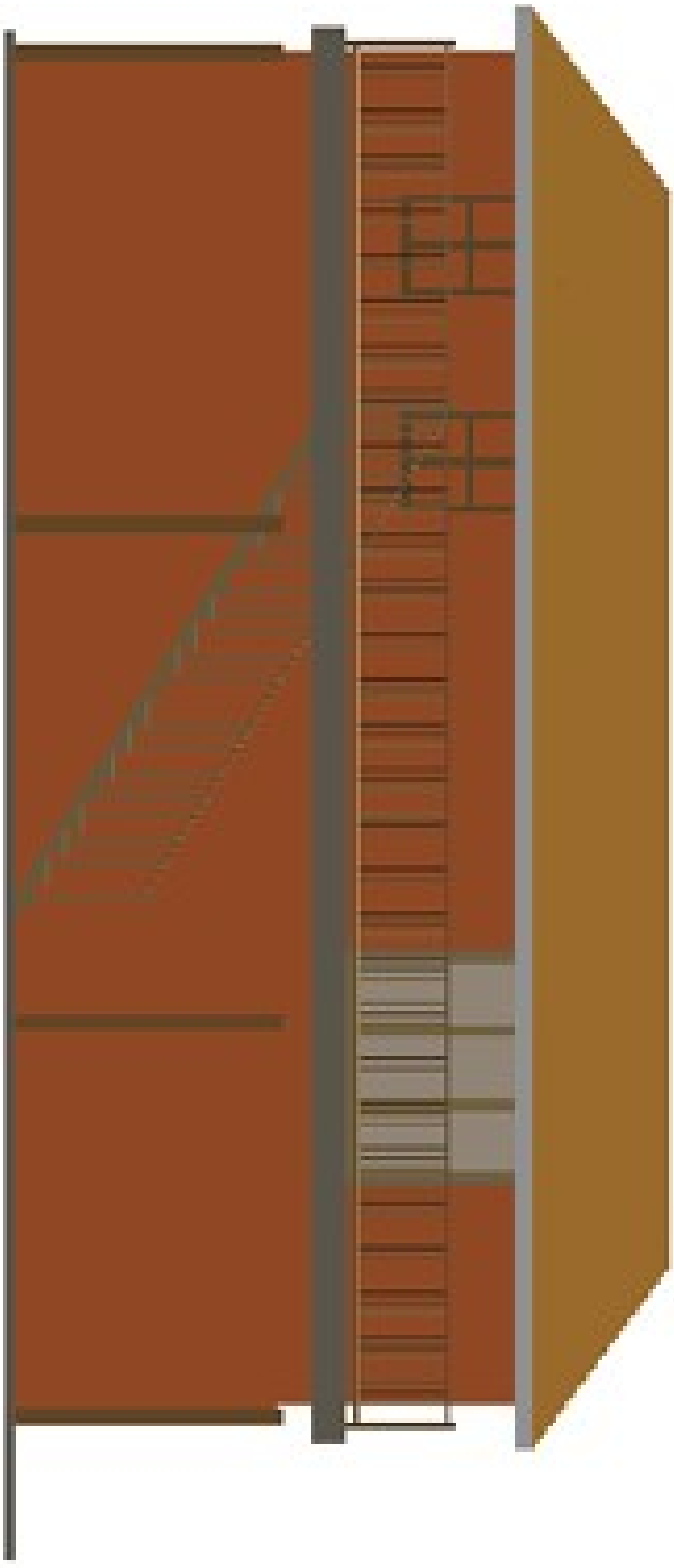


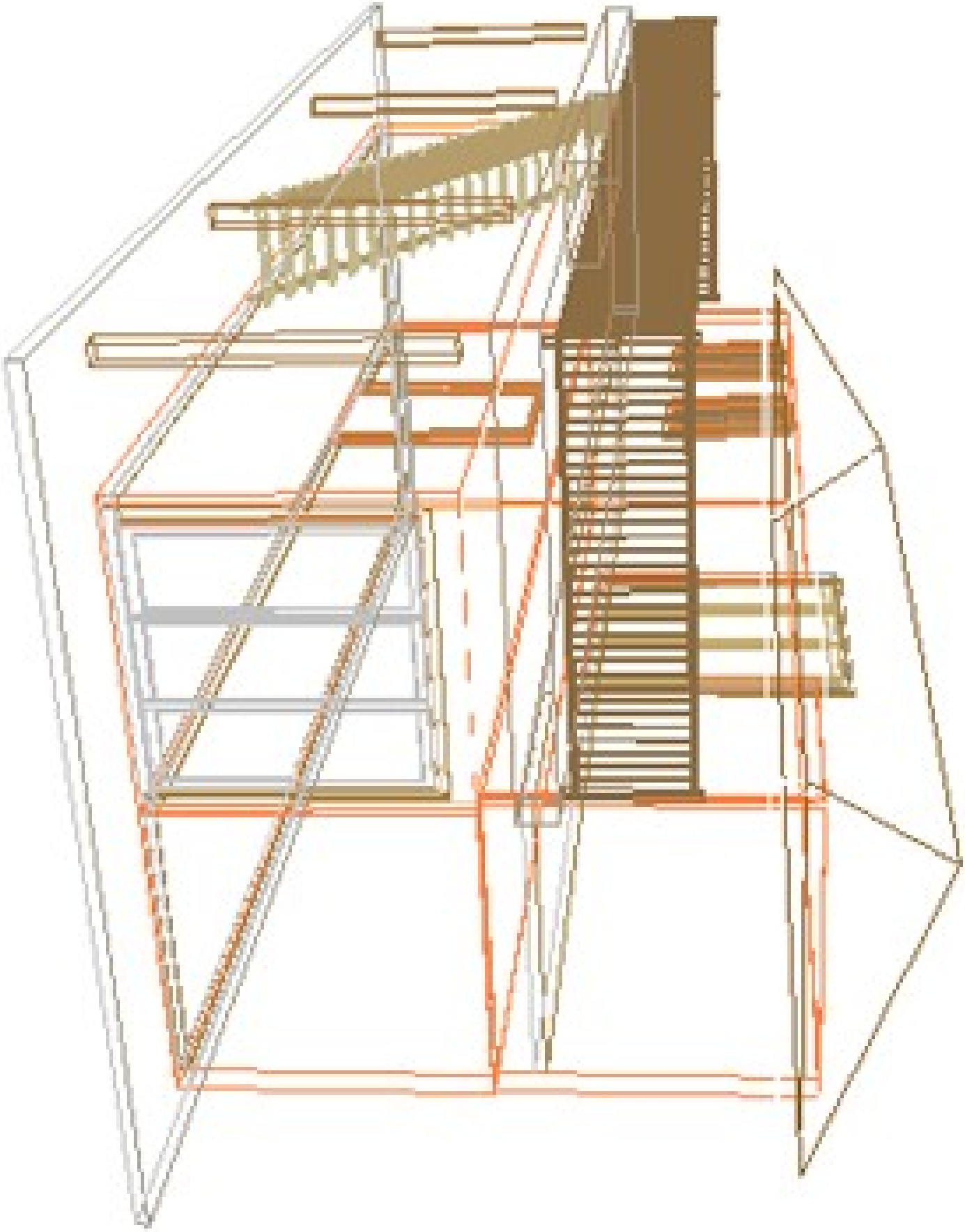


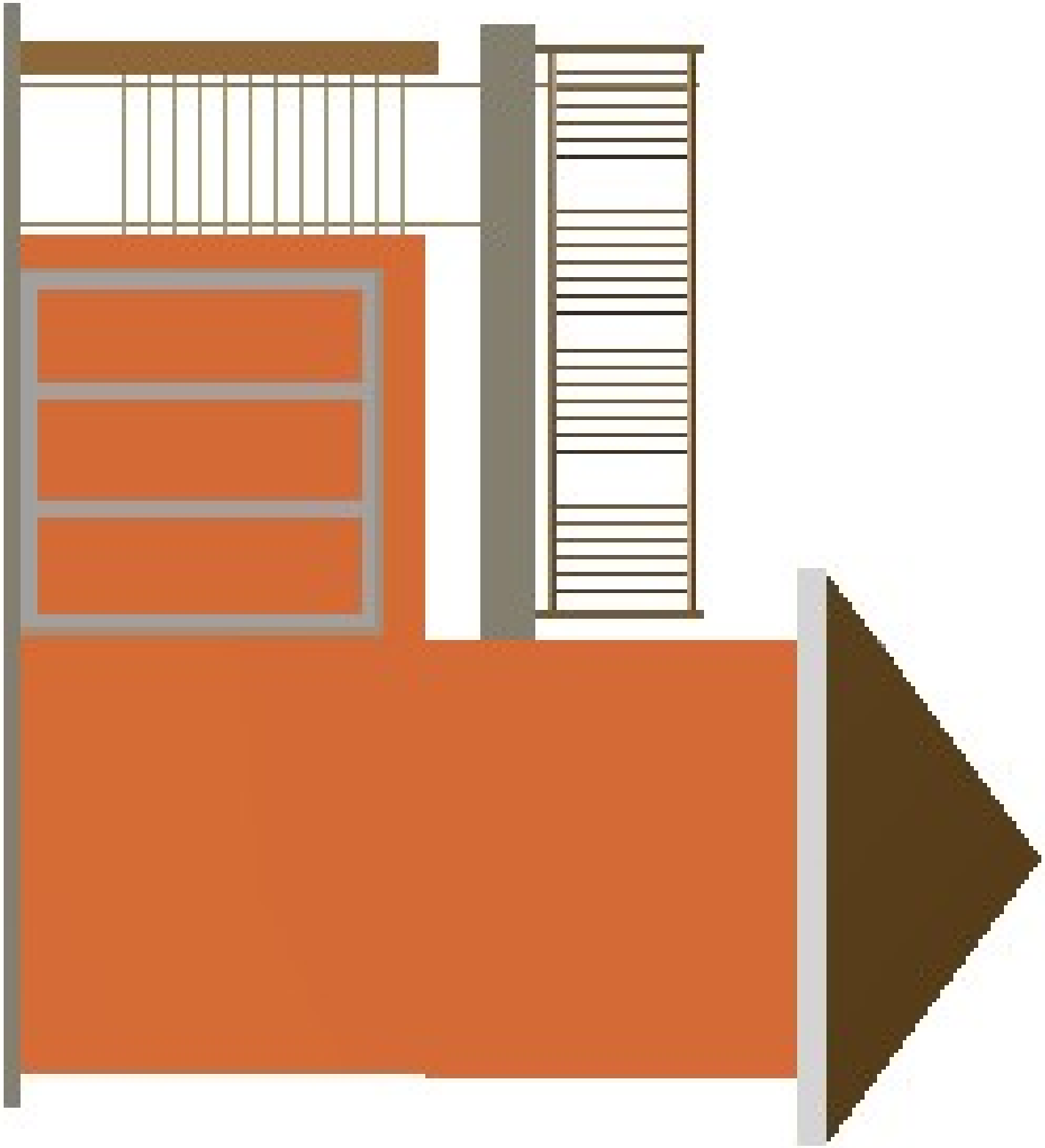













$20,960
RV/GARAGE/SHOP
STORAGE CONTAINERS
TRAILERS • CHASSIS
GLOBAL Industries
AFFORDABLE STORAGE CONTAINERS FOR SALE
Portable Garages
R.Vs - Boats - Cars Trailers

Containerized Cargo
Total Top 25 U.S. Ports
Calendar Years 1998 through 2003

(Thousand of TEU's)

U.S. Ports	1998	1999	2000	2001	2002	2003
Los Angeles, CA	2,293	2,552	3,228	3,428	4,060	4,664
Long Beach, CA	2,852	3,048	3,204	3,195	3,184	3,091
New York, NY	1,884	2,027	2,200	2,355	2,627	2,803
Charleston, SC	1,035	1,170	1,246	1,159	1,197	1,250
Savannah, GA	558	624	720	813	1,014	1,124
Norfolk, VA	793	829	850	885	982	1,093
Oakland, CA	902	915	989	963	979	1,064
Houston, TX	657	714	733	783	851	933
Tacoma, WA	496	581	647	612	769	931
Seattle, WA	976	962	960	824	850	815
Miami, FL	602	618	684	717	752	764
Port Everglades, FL	474	473	439	417	370	423
Baltimore, MD	255	255	276	273	302	307
New Orleans, LA	219	237	229	217	216	237
Portland, OR	188	210	212	206	185	210
Gulfport, MS	113	123	156	159	173	204
Wilmington, DE	127	132	123	128	133	195
San Juan, PR	137	141	152	150	159	185
West Palm Beach, FL	121	128	130	119	142	140
Jacksonville, FL	207	148	110	104	114	113
Philadelphia, PA	115	89	83	83	115	103
Boston, MA	68	79	74	64	80	93
Newport News, VA	74	80	74	45	57	80
Chester, PA	42	46	52	54	59	73
Wilmington, NC	84	74	72	67	71	72

U.S. WATERBORNE FOREIGN TRADE
CONTAINERIZED CARGO
TOP 25 TRADING PARTNERS
CALENDAR YEAR 2003
(Thousand of Teu's)

PARTNERS	TOTAL	EXPORT	IMPORT	RANK
CHINA	5,656	1,209	4,447	1
HONG KONG	1,619	327	1,292	2
JAPAN	1,603	880	722	3
TAIWAN	946	295	651	4
KOREA	898	429	469	5
GERMANY	650	183	467	6
ITALY	602	129	473	7
BRAZIL	533	145	388	8
THAILAND	496	118	378	9
UNITED KINGDOM	429	223	206	10
BELGIUM	392	236	156	11
INDONESIA	391	130	261	12
NETHERLANDS	390	166	225	13
INDIA	389	136	253	14
MALAYSIA	299	61	239	15
FRANCE	280	85	195	16
HONDURAS	275	122	152	17
GUATEMALA	268	112	156	18
SPAIN	246	88	158	19
COSTA RICA	245	79	166	20
PHILIPPINES	221	80	141	21
DOMINICAN REPUBLIC	216	118	98	22
AUSTRALIA	210	131	78	23
TURKEY	196	82	114	24
CHILE	190	55	135	25

Additional Sources

Joint Committee on Tactical Shelters JOCOTAS, U.S. Army Natick Soldier Center

The Defense Ammunition Center & School

Guide to Container Inspection for Commercial and Military Intermodal Containers MIL-HDBK-138

Intermodal Association of North America (www.intermodal.org)

U.S. Bureau of Transportation Transtats (www.transtats.bts.gov)

International Organization for Standardization (www.iso.org) ISO 668, ISO 1161, ISO 1496, & ISO 6346

American Society for Testing and Materials (ASTM)

When Excavators and Backhoes Become Cranes by Walt Moore

Stacking Shipping Containers on Land by J. Cooper, J. Kilmer, and B. Wands (Fermi National Accelerator Laboratory)

Random Lengths of Eugene, Oregon

END INTERMODAL SHIPPING CONTAINERS FOR USE AS STEEL BUILDINGS SECOND EDITION

ADDITIONAL DOCUMENTS TO FOLLOW:

Stacking Shipping Containers on Land

by J. Cooper, J. Kilmer, and B. Wands

MIL-HDBK-138