Building Studio Doors

- By JH Brandt ©2014

The following information will guide you through the construction of your studio doors and doors with windows.

We will be building a mass – spring – mass / mass - air - mass system similar to your studio walls. Any opening in the walls (window or door) will defeat the sound transmission loss rating of the walls if the window(s) or door(s) do not have the same STL.

A small crack or hole can mean disaster. Seals are critical on a studio window and especially a studio door since the door must be opened and closed.

We will build our door/window systems from available materials. There are parts that can be ordered and/or special built, but I will try to keep the bill of materials in commonly available items. Or you can order one of our custom-built doors. See http://www.jhbrandt.net/products.html

DOOR PANEL CONSTRUCTION & WINDOW GLASS SELECTION

The door panel is all about mass. You must match the mass of door or window glass with the mass of each wall. If you can not buy a solid core door panel, you can make one. The important part of making a door panel is that it will be rigid and *square** when finished.

* meaning will all four corners at precise 90 degree angles.

Following the mass rule, you can build your door from solid hardwood, MDF, or sand-filled by matching the weight of the walls, so that it has the same or (preferably) higher mass than the walls. Find the mass of your interior and exterior walls by using the chart below to calculate the ratio based on the mass of the materials. ie; MDF has a density of about 750 kg/cubic meter or 46.82 lbs/cubic foot. If the chart below does not have the material used in your construction, download my *ReflectionsBoundariesMass* Excel spreadsheet. It should have it listed on the Materials Mass tabs. You will find it here.
You must measure the thickness of the material(s) used in the construction of the wall and divide the density listed in the chart below by that thickness to determine the surface density of the partition. If multiple materials are used, do the process for each material and add the results. Take the sum and

multiply it times the area of the door or window to be built. The product will be the total weight required of the door or window glass. **Build accordingly**.

- And don't forget to add a little *extra* mass to the door panel because there is always something in the real world that will circumvent your efforts.

Material	kg/m³	lbs/ft³
Acrylic Glass	1180.0 kg/m³	73.66 lb/ft³
Brick, common red	1922.0 kg/m³	119.99 lb/ft³
Brick, fire clay	2403.0 kg/m³	150.01 lb/ft³
Cement (foundation)	2499.0 kg/m³	156.01 lb/ft³
Chip board, hard	750.0 kg/m³	46.82 lb/ft³
Concrete, Gravel	2403.0 kg/m³	150.01 lb/ft³
Cork, solid	240.0 kg/m³	14.98 lb/ft³
Earth, packed	1522.0 kg/m³	95.02 lb/ft³
Glass	2579.0 kg/m³	161.00 lb/ft³
Granite, solid	2691.0 kg/m³	167.99 lb/ft³
Gypsum board	800.0 kg/m³	49.94 lb/ft³
Hard board	800.0 kg/m³	49.94 lb/ft³
Lead, rolled - see metals table	11389.0 kg/m³	710.99 lb/ft³
Loose Sand	1442.0 kg/m³	90.02 lb/ft³
Marble, solid	2563.0 kg/m³	160.00 lb/ft³
Mass Loaded Vinyl (barium filled)	2139.0 kg/m³	133.53 lb/ft³
MDF	750.0 kg/m³	46.82 lb/ft³
Oak, red	705.0 kg/m³	44.01 lb/ft³
OSB	658.0 kg/m³	41.08 lb/ft³
Plaster	849.0 kg/m³	53.00 lb/ft³
Plywood - sanded structural & marine	577.0 kg/m³	36.02 lb/ft³
Plywood A,	500.0 kg/m³	31.21 lb/ft³
Plywood B	596.0 kg/m³	37.21 lb/ft³
Plywood, birch A-quality	682.0 kg/m³	42.58 lb/ft³
Plywood, birch B-quality	583.0 kg/m³	36.40 lb/ft³
Plywood, pine,	500.0 kg/m³	31.21 lb/ft³
Sand, dry	1602.0 kg/m³	100.01 lb/ft³
Sawdust	210.0 kg/m³	13.11 lb/ft³
Soft iron	7700.0 kg/m³	480.70 lb/ft³
Soft PVC	1500.0 kg/m³	93.64 lb/ft³
Stone, crushed	1602.0 kg/m³	100.01 lb/ft³
Water, pure	1000.0 kg/m³	62.43 lb/ft³

For example; Your exterior partition is common red brick 8.9cm thick and it is plastered on the inside 12.5mm thick. Take the 1922kg/m3 density of the common red brick and multiply it by 0.089, (8.9cm = 89mm = 0.089m) the product is 171.058kg/m2. Next take the 849kg/m3 of the plaster and multiply it by 0.0125 and you get 10.6125kg/m2. Add the two results together which will equal 181.67kg/m2. Now let's say that your door is 1 meter wide by the standard 2.03 meter high. Your door is 2.03 square meters and therefore must weigh AT LEAST 2.03 times 171.058kg which is 368.79kg.

- Now for you folks who work in feet and inches. ;)
For example; Your exterior partition is common red brick 3 1/2" thick and it is plastered on the inside 1/2" thick. Take the 120lb/ft3 density of the common red brick and multiply it by 0.2916, (12 divided by 3.5 = 0.2916 of a foot) the product is 34.992lb/ft2. Next, take the 53lb/ft3 of the plaster and multiply it by 0.0416, (0.5 divided by 12 = 0.0416 of a foot) and you get 2.2048lb/ft2. Add the two results together which will equal 37.1968lb/ft2. Now let's say that your door is 3 feet wide by the standard 80 inches (6.66ft) high. Your door is 19.98 square feet (3 X 6.66 = 19.98) and therefore must weigh AT LEAST 19.98 times 37.1968lb which is 743.19 lbs. - And **that's** a heavy door!

Do the same process for the interior partition.

I have simplified the process for glass selection in my Reflections Boundaries Mass Excel spreadsheet calculator. First calculate the needed surface density and then go down the chart to find the glass thickness that matches or exceeds the density required.
If you buy a solid core door that is not heavy enough, you can beef it up with additional sheets of MDF glued and screwed to the solid door panel. You can even add sheet lead or sheet steel between the added MDF and the door for more weight. Add weight as necessary. Leave a one inch (2.54cm) space around all the edges of the door when you add the MDF panel so that it looks like a bank vault door. This will give you extra surface area to add more seals. **The seals are extremely important to the success of the door.**

Above is a cut-away of the double door stop for the *bank vault* door seal.

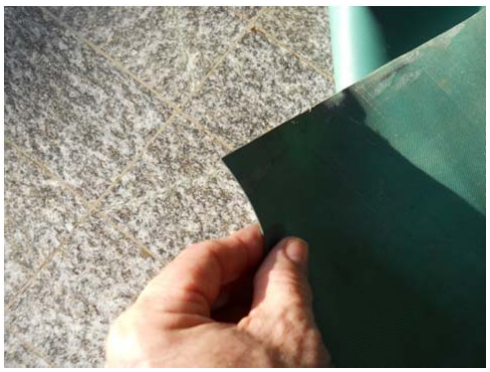
The glass that you choose for the window must either be tempered or laminated glass. Reason; Tempered glass is superior to float glass for acoustic isolation due to it's rigidity/hardness & the plastic inner layer of laminate glass provides internal structural damping for the glass which improves the STL.

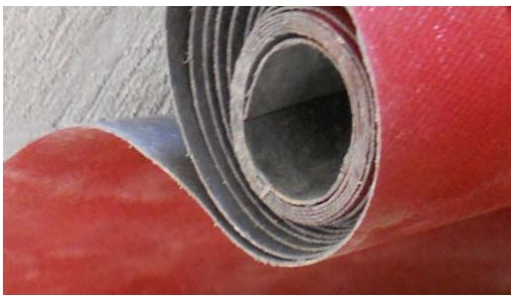
You must use a glass thickness/mass that matches or exceeds the mass of the wall. For example; Your wall is comprised of 2 layers of 5/8" (15.9mm) gypsum board. The mass of this wall is 3.8 lbs per square foot or 20.7 kg per square meter. The glass must match or exceed this weight. Therefore a **minimum** of 3/8" or 10mm thick laminated glass **must** be used. Use a different thickness for the second pane and always thicker. Due to other factors that always occur in real-world situations, I highly recommend going one size up with the window glass thickness to ½" or 13mm thick. Follow the same philosophy for the door mass.

VERY IMPORTANT!!:

See the photo of the double-wall, wood frame construction above (top of this page); Note the black section that goes across connecting both frames. This **MUST** be installed prior to installing the door frame. This rubber seal must also be caulked to both frames to effectively seal the wall gap. If not, you will experience stale odors from the wall cavity. This rubber seal (360 degrees) will seal the door 'tunnel'. This is required for any door installation that consists of 2 isolated walls in either wood or masonry.
See also the door drawings and details at the end of this document.

Rubber membrane installation





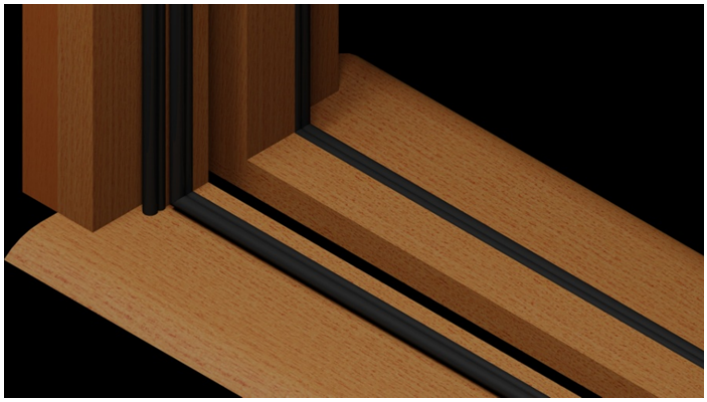
The photos above show some examples of the rubber material found here in Indonesia. I'm sure that you will be able to find something similar in your part

of the world. The material show here is used under roofing but it is NOT bitumen (asphalt or tar) product, it is natural rubber.
Polymax PRIMA - Chloroprene Rubber Sheet is available in the UK & General Purpose-Economy Grade Rubber Roll is available in the U.S. Para Rubber in NZ & Complete Rubber in Australia…
Buy 1/32" or 0.8 – 1 mm thickness. The above mentioned websites were found through a Google search. I'm sure that you will be able to find other suppliers in your area. You don't need to buy these exact products but any product with the same characteristics will be fine.
Install the rubber membrane just after framing of the decoupled walls – or, if you are building with masonry, after the walls are built.

Note the beads of caulk in the photos above. It is necessary to seal the rubber very well to both partitions. Continue 360° in the wall opening, INCLUDING the bottom. Seal the overlap!

Door Wall Frame Construction

The wall frame must be built to withstand the weight and shock of opening and closing the heavy door. Use at least 2-3 king studs plus 1 jack per side of the door opening. A strong header is required even though the wall may not be load-bearing. Always build as though the doorway or window opening were load-bearing. This is due to the weight of the door(s) which, if not well secured and braced, can (**will**) crack and destroy a wall section in time. What follows will be far more than integrity loss of the isolation shell.



Due to the weight of the doors, you must have resilient sway bracing on either side of the door frames. This is necessary whether you use framing (wood or steel) OR block, brick, cement. You will notice, in your specific design drawings, the sway bracing on each side of a door or window.

The render of the framing above shows double king studs on each side of the door opening with jack studs supporting a strong load bearing style header.

It is also recommended that you build your double wall windows in the same manner with extra king studs and load bearing type headers. See the "Building Studio Windows" doc.

The door frame should be made with 5/4" - 2" (3cm - 5cm) thick board for strength. Hinges must be heavy duty ball-bearing and at least **4** must be used. I recommend 4 – 6, depending on the weight of the door and the rating of the hinges. (Check the specs – **DON'T GUESS**!) Buy only high quality steel hinges with ball bearings. Here is not the place to go cheap. It will preserve the door, frame, and seals.

The door frame must be square and plumb and have no gaps between it and the wall studs. Seal with 3 beads of good acoustic rated caulk, one bead on the inside, middle and outside of the stud **before** attaching the door frame. If shims are necessary, use them & fill the large gaps with fiberglass insulation or minimally expanding foam, and caulk well. The frame gaps must be sealed perfectly.

THE DOOR CLOSER

Get a good door closer. Bottom line, these studio doors are really, really heavy and you must have a good closer to prevent damage to the door, frame, and People. You should match the strength of the closer to the mass of the door. Buy commercial units. Don't skimp on this, otherwise you'll be replacing them every year.

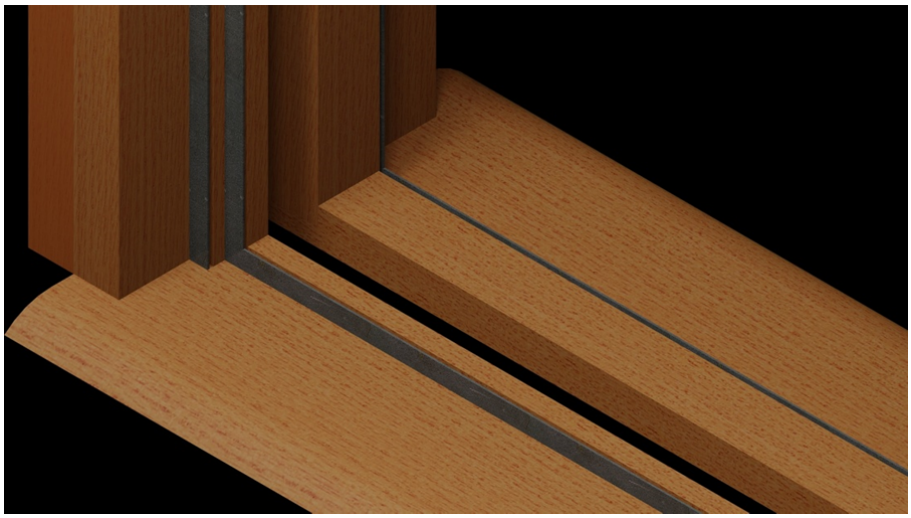
DOOR STOP CONSTRUCTION

This is the part of the system that 'stops' the door when you swing it closed. Your rubber seal will attach to this 'stop' and seal the door when closed. I recommend using a full ¾" or 20mm thick stop and make it at least 2" or 50mm wide (deep) for strength. Use Poplar or hardwood. Use professional wood glue and finish nails to attach it to the frame. We use polyurethane glue and clamps. If the stop is weak, it will crack and your seal will fail.

DOOR SEALS

To complete the isolation, good seals must be installed. The seal must be 100% air/water-tight. The analogy of an aquarium is appropriate here.

I recommend the double seal as shown below and to fit an additional panel to the solid core door with a drop seal as shown on the next page.



Door frame & threshold with angle-iron in the door stops for fitting the trunk rubber (balloon seal)

Door frame & threshold with the trunk rubber (balloon seal) fitted.

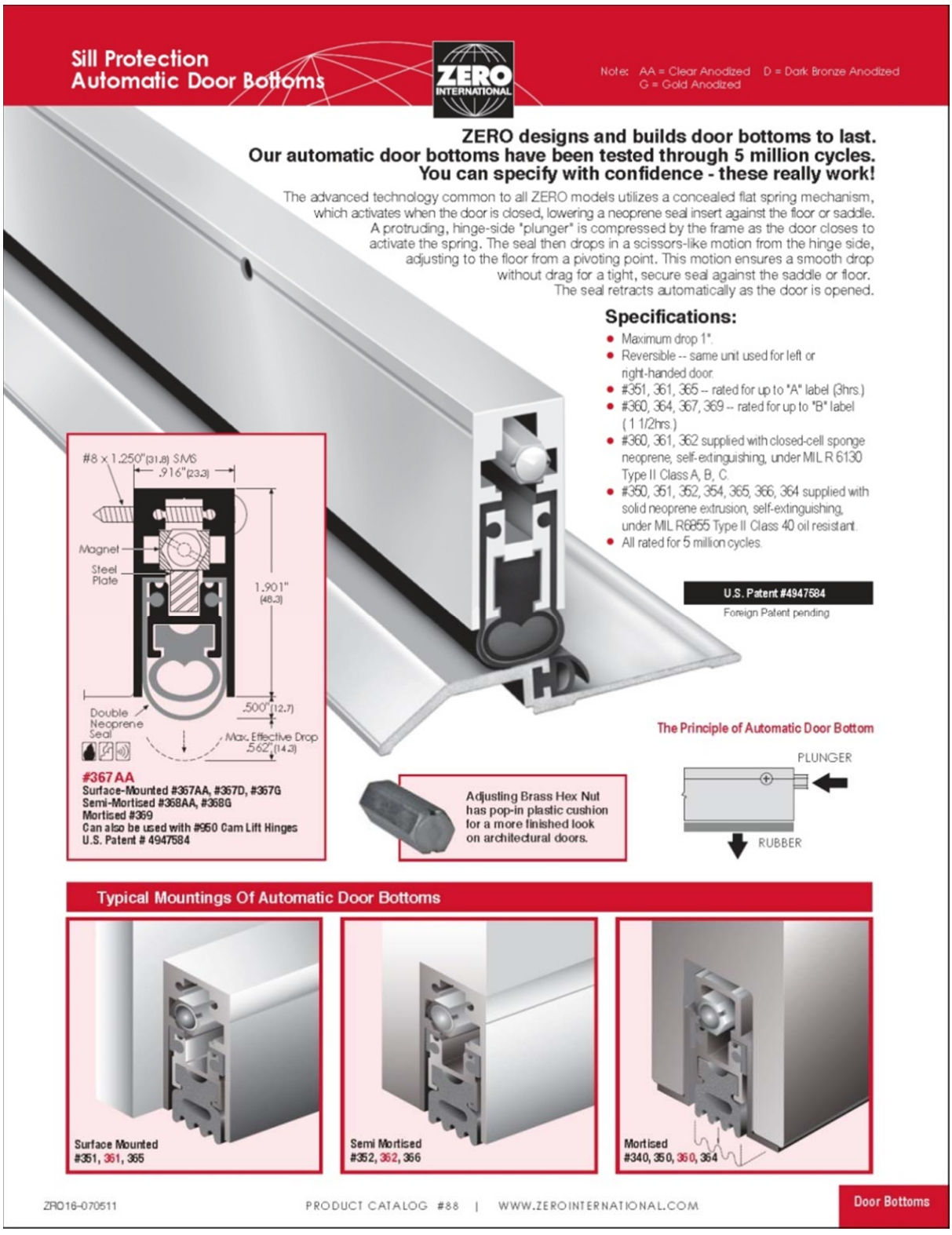
Cut the balloon seal carefully so that the corners fit perfectly together at a 45 degree angle. A professional grade contact adhesive can be used to seal the angled cuts together in the corners. It is important to check the integrity of these seals. Your isolation depends on it.

Fabric covered rigid fiberglass or rock wool is placed between the frames to add absorption to the air space between the doors and increase transmission loss. This is important.

In addition to the fabric covered rigid, a 50mm or 2” panel of fabric covered rigid fiberglass or rock wool can be applied to

the inside of each door so that absorbent is **<u>in the cavity</u>** when the doors are closed. This will control resonances within the air space when the doors are closed which in turn will lower the resonant frequency of the door partition. This can result in an additional STL of 10dB.

At the bottom of the door install a drop seal like the Zero #360 shown below.



Door Locksets!!

I recommend the mortised type of lockset shown to the left, if you can get them. Buy commercial grade. They are much easier to seal. If not, you can use the standard, round hole, drilled through lockset. But care must be taken to seal the lockset. A poorly sealed lockset/handle alone can ruin the isolation provided by a good heavy door.

Seal the lockset by purchasing some thin closed cell foam - like gasket material. Lay your door handle on the sheet and draw around it. Cut it out like a gasket & poke holes where the lever shaft will be, insert into handle and install on the door. Don't use caulk, as it will 'gum up the works'.

Seal and double check everything

From start to finish try to imagine that you are building an aquarium and that you will be filling the room with water. You don't want ANY leaks. Think of every piece and how it will affect the whole. If you have any questions or concerns about a particular part or wall, please contact me immediately for answers.

Again; after your door / door frame assembly is complete, you should place fabric covered rock wool or rigid fiberglass in the gap between the two frames, if you have double wall isolation. This does two jobs, 1. Absorption in this area improves STL, and 2. The fabric dresses the space between the two frames without using wood which would otherwise couple the two decoupled frames.

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It should be mentioned again that the doors, being decoupled, can cause the walls to vibrate when they are opened and closed. Therefore it is very important to have adequate sway bracing between the two isolated walls. The very best sway braces are the DNSB and second best is the WIC by Mason Industries.

DNSB sway brace WIC sway brace

Doors should have 4 sway braces. Two on each king stud; one at mid-door height and another at the header.

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The ULTIMATE STUDIO DOOR (SAND FILLED):

- NOTE: the following is only ONE example; Your specific plans should be followed exactly as they were designed for **your** installation.

You will need a table saw, thickness planer, a stapler (preferably an air stapler), 3 to 5 bags of dry sand and LOTS and LOTS of glue. For one door you will need 2 sheets of ¼" - ⅜" plywood, and 2 sheets of a plywood hardwood veneer and about 3-5 seven foot 2 X 4 studs (38mm by 89mm by 2.2 meters).

Using a table saw, rip the wood down the middle to create boards that are 1½ inches by 1¾ inches. You are going to build the frame with this and these boards will determine the thickness and therefore the weight of the sand going into this door.

Plane the boards so that they are all the same thickness and have square corners. Do not take off too much wood, this is the frame and does not need to be perfect – just flat. Determine the width of the door by measuring the frame. If the frame is exactly 32 inches, left to right, then your door should measure 31¾ inches wide. We leave 1/8 inch on each side. Top and bottom, do the same. Metric; make the door 3mm smaller than the frame on all sides.

Have the door very well supported on a sturdy table or saw horses. It's going to **get** VERY heavy!

Build a square frame with the ripped 2 X 4’s on one piece of plywood. Glue all joints well, as shown above. Brace internally and insert 3 cross pieces centered at 36 inches (91.5cm) from the bottom of the door for the lockset.

Partition the top and bottom parts of the door making four open sections. Be sure to glue all the joints very well. The door shown here has a frame section for a window that will be installed. This one was for a special single door installation which doubled as a window into the Tracking Room.

Next, pour dry sand in all the spaces in the frame. Level and scrape off the excess.

Very carefully wipe off the frame boards…

…and glue & staple the top piece of 3/8” plywood to the frame, completing the door. – Shown here is a door with a window -

Next glue on the veneer plywood on both sides of the door to cover the staples or nails and give the door a finished look. An additional piece of ¾" (18mm) MDF can be added to the inside of the door to make it stepped like a bank vault so that you can use double seals. If more mass is needed, you can add a sheet of steel or lead between the MDF and the door.

*** VERY IMPORTANT ***

Dimensions in the above example are only for reference. Your specific plans should be followed exactly as they were designed for **your** installation.

If you need any further information or have any questions, do not hesitate to call, email, chat, etc. My info is:
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Tel: 62 (country code) 021 822 5088
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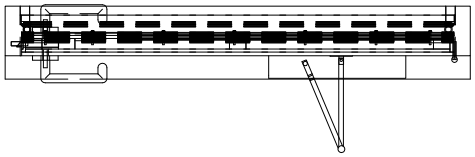
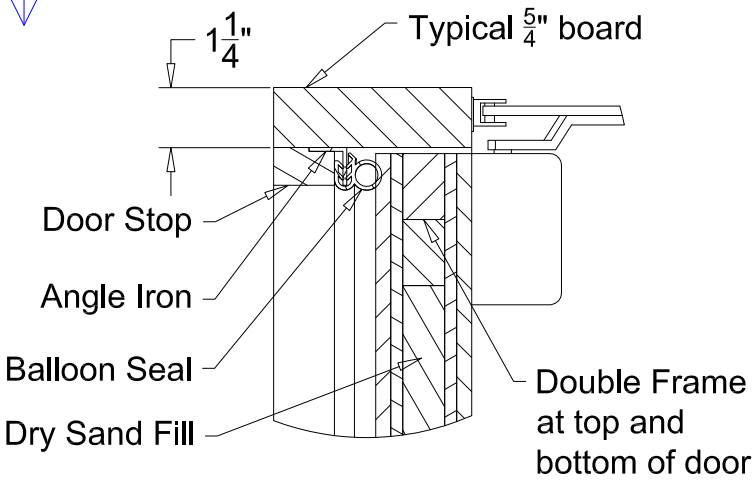
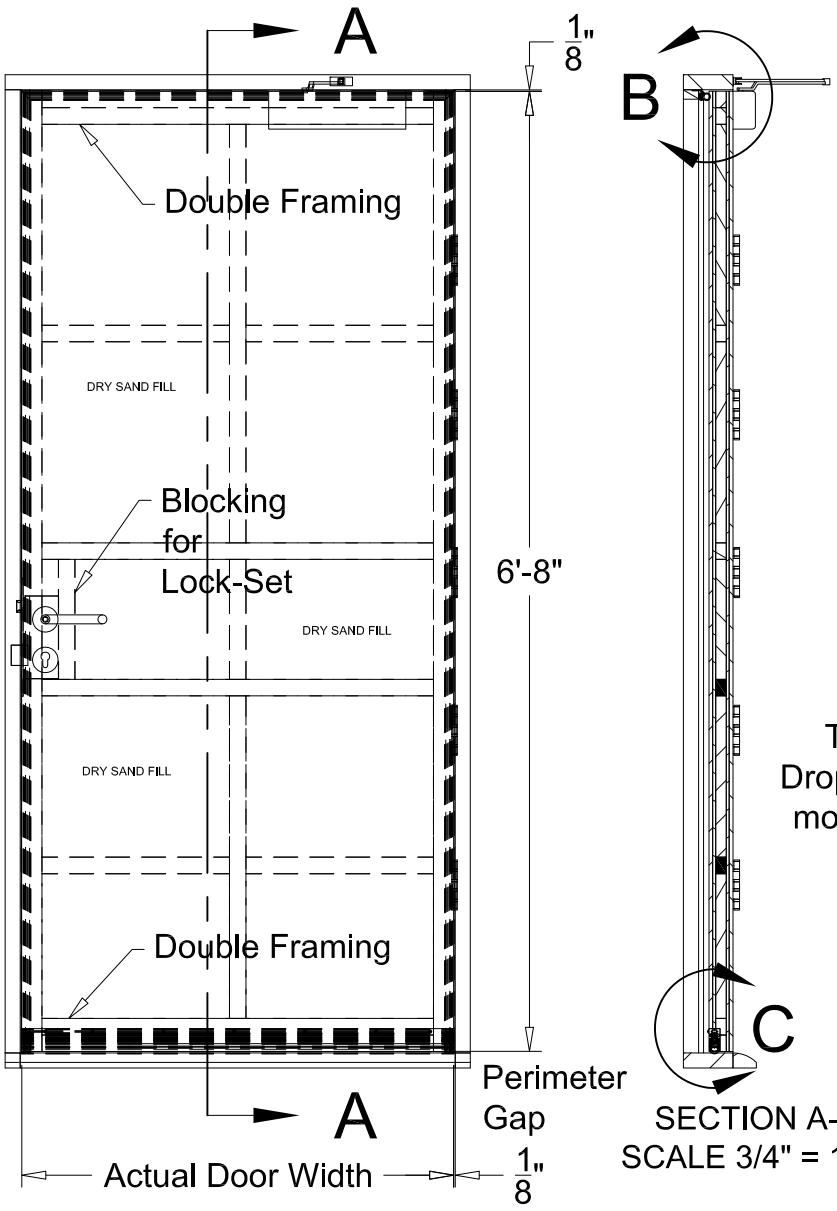
ADDITIONAL DRAWINGS AND INFO:

See the following pages…

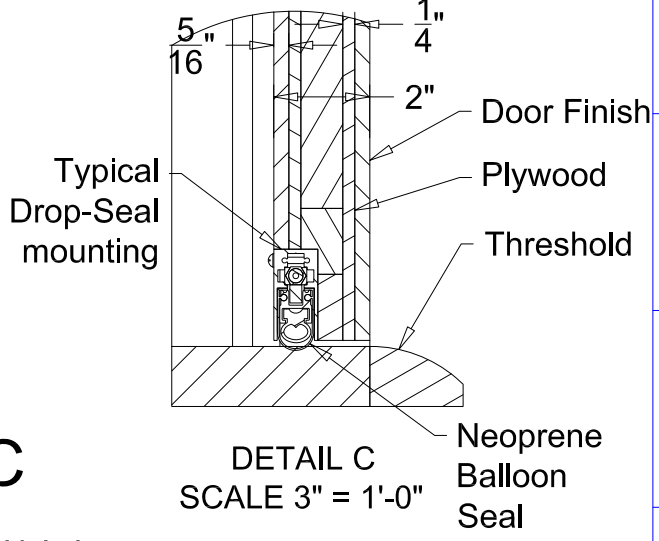




DETAIL B
SCALE 3" = 1'-0"



SECTION A-A
SCALE 3/4" = 1'-0"



DETAIL C
SCALE 3" = 1'-0"

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Project : Door Construction
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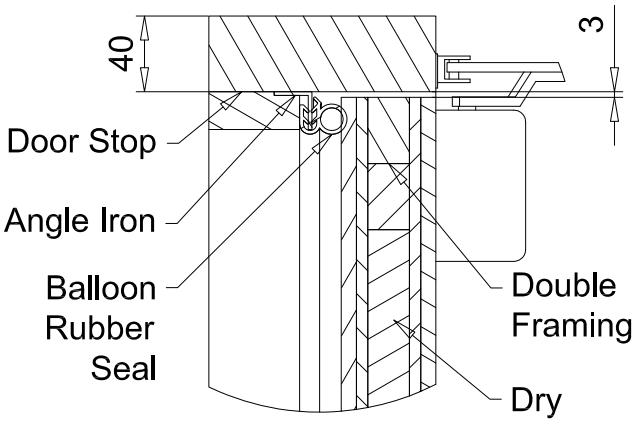
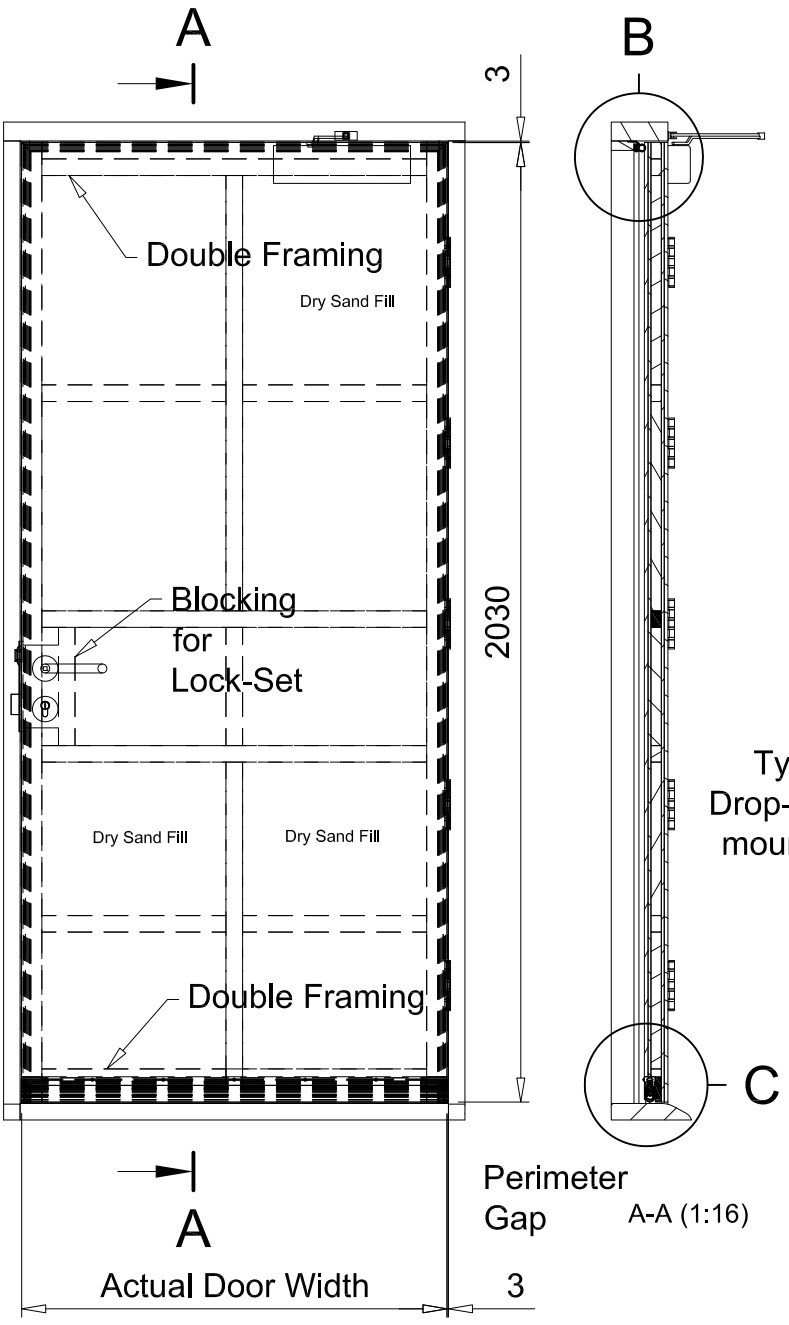
Drafter : — Date :
Drafter : — Date :
Revision/Issue : # — Date : mm/dd/2014
Revision/Issue : — Date :
Revision/Issue : — Date :
Client - Name & Address: All
Job No : 10327
Project Date: 03/15/2014
Sheet : 1 of 1
Checked : John H. Brandt — Date : 03/15/2014



B (1:4)



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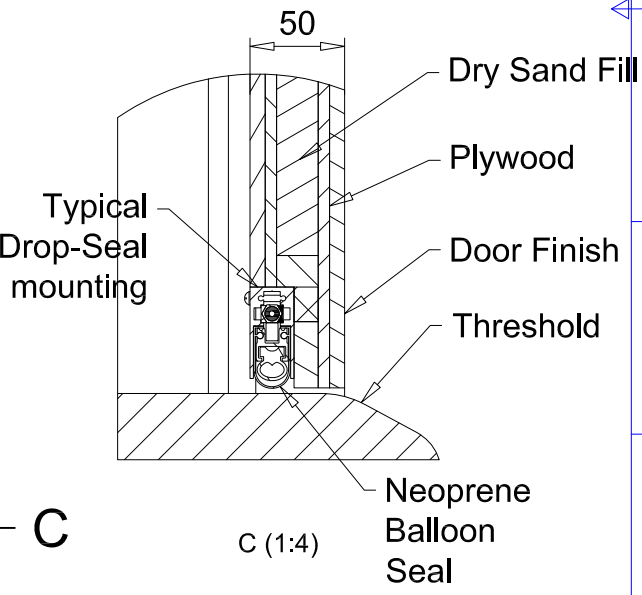

C (1:4)

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Drafter :	Date :		Sheet : 1 of 1
Drafter :	Date :		
Revision/Issue : #	Date : mm/dd/2014		
Revision/Issue :	Date :		
Revision/Issue :	Date :	Checked : John H. Brandt	Date : 03/15/2014