Designing and Building Gates and Panels

Handbook for Exhibitors

This handbook is designed to help those designing and building gates and panels to enter as an agricultural mechanics project in shows all over Texas. It is suggested that students should do research on different ways to design their gate or panel. Gates must have hinges and latches to be complete. Panels are usually displayed in multiples – at least two to show method of hooking together. Panels may have feet or slides on the bottom to set up on ground. Racks for storing or moving panels may be included. In the discussion below the description of gates can also be applied to panels.

Gates/Panels Design and Building Handbook

PREPARATION

When preparing to build a gate or panel, you must think of multiple things. These are as follows:

1. Research to determine best design for meeting purpose and objective. If building for a customer must consider their needs and specifications. Do not limit design to just meeting the customer's request if their specifications do not include those items that would make your project competitive for exhibiting at a project show. Explain this to customer prior to commencing construction. Design should take into considerations those items explained below, such as weight of gate and hinges required, post supporting gate, latches and does gate swing in or out from property.
2. Draw a working set of plans for the project so you get an idea of what it will look like.
3. Estimate of how much will the project cost? Begin a list of all materials (Bill of Materials - BOM) you will need.
4. Complete scaled drawings showing all details including hinges and latches. Drawing may include Orthographic Multiview Projections along with 3D pictorials such as – isometric and or perspective. Note: drawings should be prepared prior to building. Drawings must be complete to provide a builder or contractor enough information for them to construct project (gate or panels). Judges will review drawings to see if projects dimensions are congruent with those found in the drawings.
5. Think about the welding process, hand or machine cutting process, and any additional items that will be used during the build.

GATE SIZE - Gates can vary so much in sizes, shapes, and designs. To decide what you will do, first think of where the gate or panel is going and make sure your design is practical. A gate that is 16 feet long is most practical length for a single swinging gate, anything longer should be two swinging gates or a sliding gate.

GATE TYPES

- Hinges or swinging
- Double swinging
- Electric gates – most any gate can be opened and closed electrically. Additions design considerations are required for electric gates. Safety is an important consideration
- Cantilever type gates
- Gates on tracks – chain or cable pull
- Knock down and/or drive over gates – do not require electricity
- Others - ATM etc.

EXAMPLE GATE TYPES

Double swinging gate

Gates on tracks

Cantilever Gate

Knock down gate

GATE DESIGN - Must take into consideration the following.

1. Its purpose – livestock containment including size and kind of livestock – for example cattle including bulls and calves, or horses, goats, sheep, exotic game, etc.
2. Safety – people and animals. There should not be any sharp edges or points that would injure people or animals using the gate. For example, silhouettes welded in or on gate should not have points that could injure. Because gates and panels are designed to keep livestock restrained, they must be restrained safely. Spacing dimensions of horizontal or vertical bars (pipes) must be adequate to restrain livestock and yet not allow animals to get stuck in them.
3. How often will gate be used? This may dictate closure and latches
4. Where will gate be used? Will it be a simple gate for a back pasture, or an elaborate front entrance gate? No matter where or what type of gate it is, there are still common things to consider
5. Does the gate provide (secured) entrance? – for example, will it require a code or lock to open gate.
6. Size of Vehicles using gate – cars – trucks, tractors and equipment (plows, grain drills combines, etc.
7. Size and weight of gate. – see example below on determining load (weight on a gate) Use of gussets and braces are recommended to strengthen especially longer gates or heavy ornate gates.

8. Support for gate – Post that will be supporting gate/s. May require a header extending from posts supporting gate. Recommended that header be a minimum of 14 feet height to allow for trucks and machinery passing under it.
9. Hinges and latches required. Where will the latches and hinges be placed? If building panels, and the panels are going to connect to each other, the placement of the hinges must be identified in the specifications - drawings.
10. Examples of materials to use for building a gate – sq. tubing, pipe or round tubing, aluminum, wood, steel plates, or wire. Sucker rod should be discouraged. If using pipe, you should saddle the ends of the pipe to make it smooth and have a solid weld going around the saddle.
11. Shapes of Gates - Will there be bends in the gate? If so, does this effect the integrity or strengthen the completed project? Do bends increase the aesthetics of gate. Does purpose of bend reduce time and welds required for gate?

PREPARATION FOR FABRICATION – SET UP.

1. When thinking about the design of the project you must think about the space that will be needed to build it. In order to square the project, you must have enough room to do so. To square your project, it is suggested that you measure it across diagonally before welding it fully. Enough room must be available to flip the gate multiple times to allow for tacking on both sides to prevent warping or distortion.
2. It is also suggested to not build the project on the ground or concrete floors. Surfaces should be level to keep gate plump and true. Also, welding or cutting near concrete causes the concrete to pop and explode resulting in possibly hurting someone and damaging the floors.
3. A recommendation is to build the gate or panel on sawhorses or jack stands – something that is able to be adjusted so that the surface you are building the project on can be level.
4. Have proper bar clamps and C-clamps to clamp gates prior to welding. Intermitting welding and allowing gate to cool – normally enough to touch with bare hand before removing clamps.

FABRICATION AND WORKMANSHIP

The most common workmanship issues are:

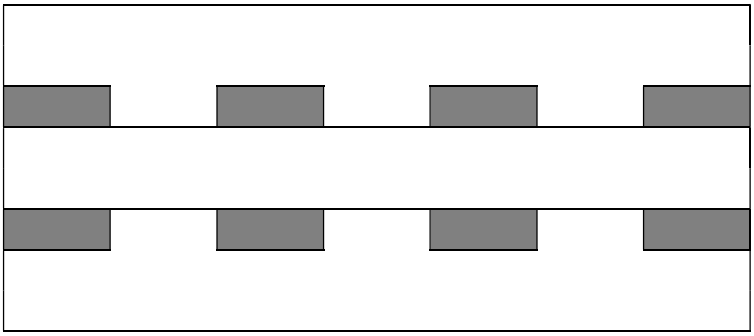
1. Poor welding – cold welds – over welding, splatter and poor fit up. Bead profile is not uniform, proper width or feathering on weld edges. Welding pipe or tubing is difficult. See welding below.
2. Gate is warped or distorted
3. Gate not square – diagonals are not equal in length
4. Poor or inadequate hinges and latches. Heavy gates may require weld-on hinges and may require more than two hinges. See Loads on Gates below
5. Latch design does not allow for some vertical movement of gate - post
6. Design using silhouettes may not be safe – sharp points – or not practical. Openings too large, flimsy and easily bent or distorted. May be too heavy if cut from thick steel.
7. Metal not prepared properly before finishing. All weld splatter or weld slag, oil or contamination must be removed. Do not grind weld joints.
8. Painting or finish. Powder coating can be used but is not rewarded. Most powder coating is done by someone else and may not be a learning experience. Using aerosol cans to

paint gates is discouraged. Using aerosol cans to paint causes runs, uneven and uniform coverage plus over spray in many cases. Brush painting is discouraged also.

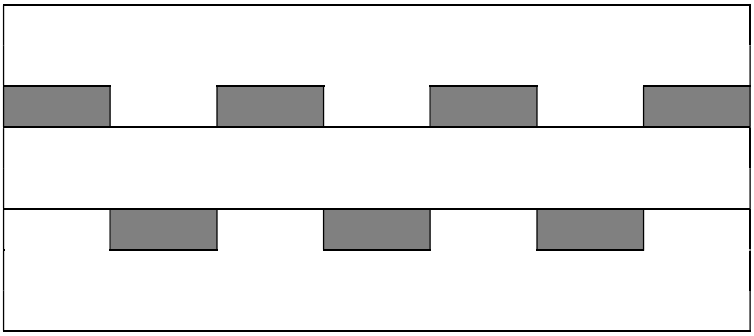
WELDING TIPS FOR FABRICATION

Correct welding techniques will provide a professional finished product that will ensure safety and reliability over time.

1. The fabricator should identify the best welding process to ensure minimal warping of the final project due to material thickness (i.e. SMAW, GMAW, FCAW, or GTAW).
2. Proper cutting and fit-up of all joints will help reduce distortion, water penetration, cracking, and ultimately gate failure throughout its use.
3. The use of Intermittent fillet welds should be utilized as needed to reduce warping due to weld heat input (chain or staggered welds pictured below).



CHAIN INTERMITTENT WELDS



STAGGERED INTERMITTENT WELDS

4. Components should be clamped throughout the welding process with C-clamps or welders clamps so the welder can easily see the joint being welded.
5. Weld every other joint on one side of the gate, then flip the gate over and perform the same steps on the nonwelded joints.
6. Warping should be reduced through the following steps:

    - Correct Weld size
    - Intermittent welding
    - Reduced welding passes
    - Correct weld placement
    - Alternating welding sequences

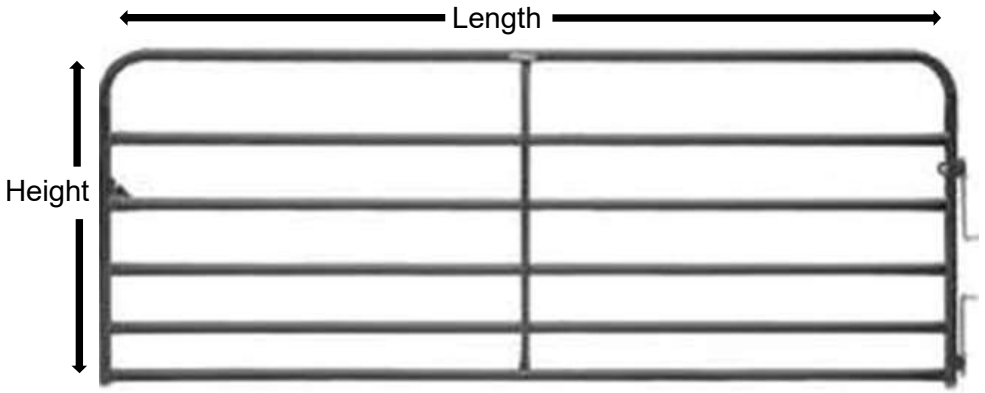
- Clamping
- Peening after welding (Peening is the process of striking the weld metal at a predetermined temperature to release the internal stresses without breaking, ultimately to “relax” the metal. This process can be performed with either a ball peen hammer or by other pneumatic/mechanical tools in the market).
- Correct amperage and volts based upon welding process used

7. All welds should be smooth and uniform in appearance.
8. All welds should be cleaned prior to finishing of the gate. All slag, silica, and excessive wire must be removed to provide an appealing finished product.
9. This does NOT mean to grind the welds; no welds should be ground down, but the grinder can be used to clean sharp edges and corners.

CALCULATING PIPE AND ROUND TUBING BENDS

Below is an example formula of how to bend bows if you are bending pipe for your gate. This formula is not perfect so it may need some adjustment. Pipe varies in structure and quality, so it is suggested to bend a piece of pipe for practice to see if there needs to be any changes to the formula before using it for the project. There is also an example on how to bend trailer bows that may come in handy for another project. With this formula, the bends are for a 90 degrees angle.

To use this formula, you must know the dimensions of your gate, for this example we are using a 12’ x 4’ gate made from 1 ¼” pipe. All the conversions are done at the end of this example, all that needs to be done is plug in the conversions where they are needed and perform the calculations. Once the calculations are complete for the length and height, add all of those measurements together for one long piece of pipe, then you make a mark at the designated measurements in order to bend it correctly. Like stated before, it is suggested that you conduct a practice bend before needing it for the project. Also, please keep in mind that the conversions are rounded up to the nearest 16th in order to be able to make the measurement using a tape measure and a piece of soapstone.



Pipe size: 1 ¼”

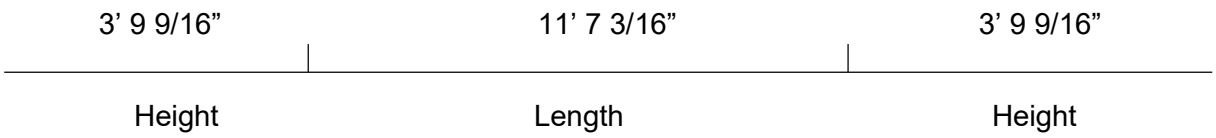
Outside Dimensions (Gates)

Length		12
Subtract 1 OD	-	1 11/16”
Total	=	11’ 10 5/16”
Subtract Full Gain (2 Bends)	-	3 1/8”
	=	11’ 7 3/16”

Inside Dimensions (Trailer Bows)

Length		
Add 1 OD	+	
Total	=	
Subtract Full Gain (2 Bends)	-	
	=	

Height		4’
Subtract ½ OD	-	7/8”
Total		3’ 11 1/8”
Subtract ½ Gain	-	1 9/16”
	=	3’ 9 9/16”



Pipe	½ Gain	Full Gain	Total OD of pipe	½ OD
1/2	7/8	1 11/16	13/16”	7/16”
3/4	15/16	1 15/16	1 3/64”	9/16”
1	1 1/4	2 1/2	1 3/8”	11/16”
1 1/4	1 9/16	3 1/8	1 11/16”	7/8”
1 1/2	1 3/4	3 1/4	1 7/8”	15/16”
2	2	4 1/16	2 3/8”	1 3/16”

CALCULATING WEIGH (LOAD) ON GATE:

On large gates – swinging – the main problem is design of hinges to carry the load (weight).

Note: Pipe hinges are not adequate for most gates. Also, if gate is to swing back against the fence, hinge must extend from gate 4 to 6 inches.

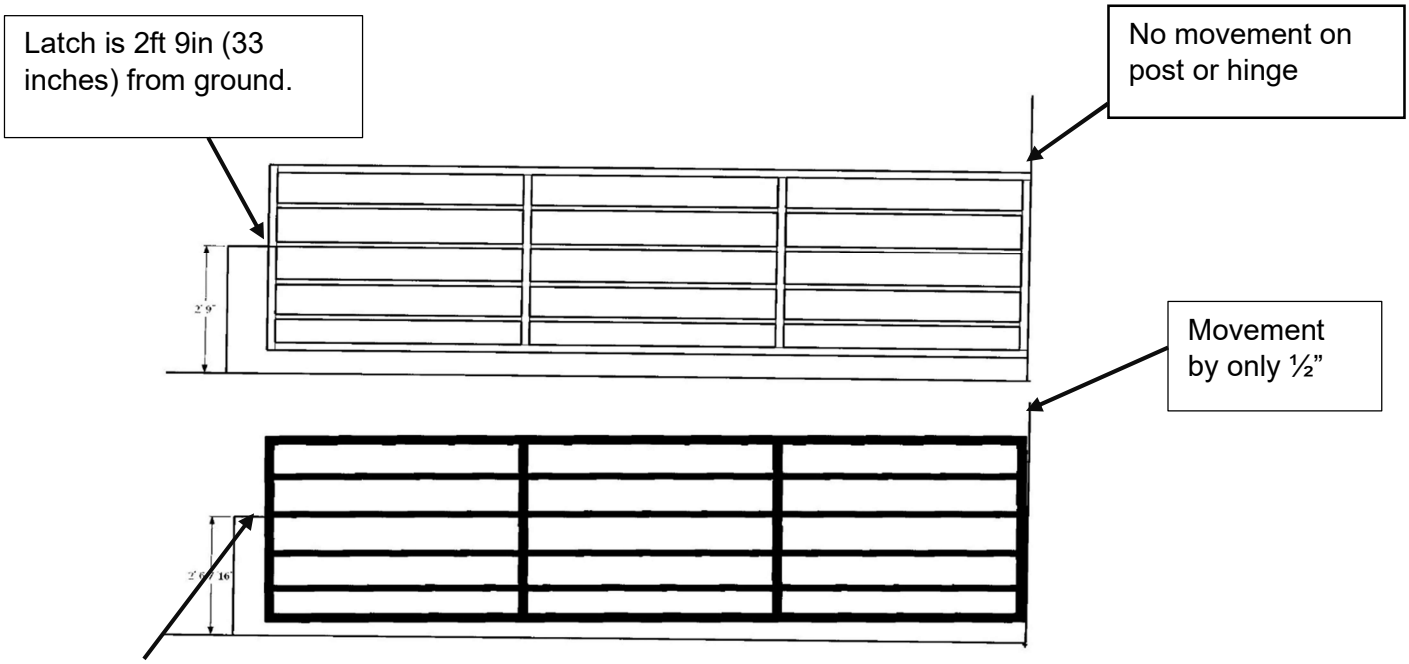
EXAMPLE PROBLEM: Given a 16 ft gate that weighs 200 lbs.- (A lot of gates that are exhibited weigh much more)

- Load on the top hinge is 1600 ft. lbs. of torque. This is determined as shown below:
- Consider gate a Uniform Loaded Cantilever Beam
- Bending Moment (BM) = 1/2WL W =weight of gate in lbs. L=Length of gate in feet
- BM= 200lbs/2 x 16ft. = 1600 ft. lbs.

This example does not even take into consideration if someone stood on the gate. That would be a point load and if the person weighed 200 lbs. and stood on the end of gate then BM = WL

BM = W(200) x L(16) = 3,200 ft. lbs. not including weigh of gate itself

The load or weight influences the sag or “droop” of the gate, especially if not hinged properly or attached to a post not designed to support it. Just a ½” inch movement of the top hinge or post will cause more than a 2” drop of latch on the end of the gate



GATE HINGES EXAMPLES-




Hinges with grease zerts are recommended for heavy gates with weld on hinges

GATE LATCHES

Another piece of the gate is the latches, depending on where and how it will be used will depend on the type of latch is used. There are many different types of latches, you must research for the best one to use depending on the use of the gate. Again, the purpose for a gate is to restrain livestock, so the latch must be safe for them, as well as safe and beneficial to the human using it. Pictured below are just a few examples of different latches. You will notice that all latches depicted below requires that the latch align up with the receiver. Any significant movement – sag of the gate will prevent latch from securing gate.





PANELS

There must be the proper footing to stabilize the panel as it won't have hinges to swing on. With that being said, there still needs to be hinges or some type of latch for the panels to be hooked to one another. It may not necessarily be a latch, but a simple chain could work.

When showing a panel at the major agriculture mechanics shows, it is advised to exhibit more than one to show how the panels are to work with each other.

FINNISH – PAINTING:

Before any paint should be applied to the project, it must be cleaned from any burrs, sharp edges, welding BBs, whiskers, and wires. Depending on where your project will go once completed, will depend on what type of finish you will do.

No matter where the project will be installed, it should still be primed and painted properly. Having knowledge of this process is important so the exhibitors can explain it to the judges.

PRESENTATION

When presenting your gate or panel at a major agriculture mechanics show, it is important to make sure it can stand up on its own and be safe. If you can safely (and with limited space) demonstrate how the gate will work at the show, you are more than welcome to as it would be an asset to display. This demonstration could be the gate hanging on hinges, or on a track system.

Part of presenting your project is to know exactly why and how you built it. You must explain each step of the building process with details to the judges. Something that will help with the presentation process is a documentation book. Things to include in the documentation is 1) drawings of the project 2) bill of materials 3) photographs and 4) research

1) Drawings of the project must be detailed enough that someone else can build the project just like you did. This should be drawn to scale with proper lettering and dimensioning. Should include multiple views of the project.

    It has been suggested but not required- that all welded sections should be documented in the final drawings with approved welding symbols from the American Welding Society's AWS A2.4 Standard for Symbols for Welding, Brazing, and Nondestructive Examination; this should include the weld joint configuration, weld type, and welding process used.

2) Bill of materials (BOM) is a list of everything that you used to build your project. This includes the item, description, size, quantity, unit, cost per item, extended costs, and total costs. You must keep all receipts for everything bought for the project.
3) Photographs are to be taken during the whole fabrication process of the project, majority of these should include the exhibitors safely working. Students should be wearing the proper PPE in all pictures. Please limit the total amount of pictures to 40, so the judges can look through everything thoroughly. Pictures should be technical in nature and sequenced, labeled and in good quality. Documentation package is *not* a scrap book.
4) Research involves the exhibitors to research and understand everything that went into the project. Exhibitors are to find the Safety Data Sheet (SDS) on all chemicals, such as paint thinner, primer, or paint. This is for the exhibitors to be familiar with all products used.

The post dimensions that the gate is going to be attached to should be addressed even though it is not on display with the gate, this is something the exhibitors should have knowledge of.

Something that might be helpful to the exhibitors for presenting is to describe any shortfalls or complications with the project and how they overcame them. The main reason for agriculture mechanics shows is for students to learn various skills that they are able to use in the future. They are to learn the process of building a project and learning how to overcome an issue if it ever arises. The purpose for this handbook is for the students LEARN.

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References:

Documentation Check Sheet -
http://jamshow.org/2020%20JAM/Documentation%20Check%20Sheet%20R20.pdf