

Structural Component Material Selection, Design, and Fabrication

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Abstract

Material selection plays a vital role in the in the design and fabrication of the structural components that will be used in an electronics project. Material selection affects the cost, size, weight, strength, fabrication and assembly of the structural components to be used. The type of material selected requires the user to also be familiar with fabrication methods for that material, since some materials can be harder and more expensive to complete the fabrication process on than other.

Introduction

There are three basic structural materials that will be examined in this application note; wood, steel, and aluminum. The advantages and disadvantages of using each type of material will be covered. This will include the cost, size, weight, and strength properties of each material as well as the possible fabrication methods for each type of material as well as the advantages and disadvantages of different of the different types of fabrication methods available for each type of material including using hand and power tools.

Objective

The objective of this application is to give a detailed description of the various material and construction methods available for manufacturing structural components of an electronics project to help others decide which materials and fabrication methods will best suit their needs.

Using Wood as a Structural Material



Wood is one of the most basic structural components that can be used in an electronics project. It is very low cost compared to other structural materials, and 8 foot long 2x4 is around 3 dollars. It is easy for those with minimal fabrication skills to manipulate safely into the structural components they desire and it can be designed to create relatively light weight components depending on the size of the structure and amount of strength or durability required in the structure being built. Some of the basic tools that can be used to fabricate wooden structures can be as simple as using a hammer and a hand saw to manipulate the material. It can easily be assembled using nails, screws, and glue.



More advanced tools such as power tools can be used to increase the speed and precision of the fabrication process. This adds slightly to the complexity of fabricating with wood as additional skills are required to use these tools safely and effectively. Also, there is an additional cost incurred if these tools are required to be purchased to complete fabrication.



The main disadvantage to using wood as a structural component is that it is relatively low strength per volume compared to steel and aluminum. This makes wood a good structural component to use if there is very little load to bear and size is not an issue. For stronger, more durable structures a relatively large amount of wood would have to be used to achieve similar strength capabilities of steel or aluminum. The size of the structure would naturally have to be much larger using wood. The user would then have to decide if the cost benefits of using wood outweigh the added size of the structure by using this material.

Using Steel as a Structural Material



Steel is another widely used structural component, it is much stronger than wood per volume, allowing less material to be used in a structural components design. Steel is significantly heavier than wood though, which is one of the tradeoffs of using steel instead of wood. The main disadvantages of using steel are the additional costs incurred by using it. Using steel to create a similar structure to a wooden one would cost an estimated 3-5 times as much. Another disadvantage to using steel as a structural component is that added complexity of fabricating with it. It is not easily manipulated by simple hand tools as wood is. Heavy duty power tools are typically required to fabricate with steel, adding to the cost and skill required.



Assembling a steel structure is also more complex than a wooden one. To assemble steel structures, the pieces must be either drilled and assembled with bolts or welded together. An advantage to bolting pieces together is that they can be easily disassembled and reassembled to save space. Once steel is welded, it is impossible to separate the pieces without cutting them apart since they are fused together in a permanent bond. Welding can produce a lighter and more stable structure than drilling the pieces and bolting them together. It requires the user to learn another skill though, which is more dangerous and complex than using basic power tools. Steel also has the potential to rust. If it is going to be used outdoors or in a humid environment it would require a coat of paint to ensure longevity of the structure produced.



Using Aluminum as a Structural Material



The third and final structural material that was considered to be used for our project is aluminum. It is a strong, lightweight, durable and the skills required to fabricate with it fall somewhere between that of wood and steel. Aluminum can be manipulated much easier with hand tools than steel or it can be manipulated in many of the same manners that steel can be. The fabrication of our project structure was completed using hand tools, as well as some of the power tools available in the machine shop available in the basement of the engineering building. The main drawback of using aluminum as a structural component as opposed to steel is that it is slightly more expensive. Aluminum is similar in strength to steel and similar in weight to wood, allowing us to use a minimal amount of material and achieve a strong, lightweight

frame for our project that still kept costs well within budget. It also does not need an paint or coatings to protect it from the elements for maximum longevity.