

# History of timber in construction construction essay



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NameInstitutionComparing Glulam with Steam Frame2. 2 Literature Review2.

2. 1 History of timber in construction

Right from the dawn of man, wood was used as a construction material to build structures for shelter. Man had to seek protection from predators and harsh weather conditions using protective cover that usually comprised of dugouts, caves, reeds, twigs, wood, mud, stone and snow. It is proposed that the first primitive structure was invented when early man pulled down a tree branch with full foliage (Guilhemjouan, 2013). The use of timber in construction dates back to 500 to 100 B. C. Timber was spatially used in roof constructions by the ancient Roman and Egyptian civilizations that majorly used stone in buildings. Most noteworthy during the period is the development of the ten and mortise joints in timber framing. Over the subsequent thousand years in Europe, the use of timber frames heightened in areas with vast timber resources. Primitive construction techniques were employed and as a means of foundation, timber was either driven or laid onto the ground. Timbers were tied together using primitive rope of animal hides. Advanced joinery techniques were developed to build more permanent and decent houses using timber frames. Stone foundations provided superior support for the houses, and prevented rapid deterioration of the structural posts. Timber frames were permanently fastened using joinery techniques. In Europe, modern timber framing was developed in the 9th and 10th centuries and is characterized by exceptional building skills (BRTW, 2011). Timber framing techniques would later evolve across Asia, Africa and the undiscovered Americas. Wood is usually cut longitudinally in either two planes: radial and tangential. Radial sections are formed along rays or the log's radius and at right angles to annual rings. The logs are cut in quarters to form planes of

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quarter sawed lumber. The rings are parallel bands that are closely spaced and the rays have the appearance of scattered blotches. Tangential sections are formed tangential to annual rings and the log's face and perpendicular to rays. Annual rings appear as wavy and irregular patterns (Armstrong, n. d.).

Figure 1. Wood planes, A-Transverse, B-Tangential, C-Radial

Timber is categorized into two: Hardwood and Softwood. Hardwood comprises of tree and shrub species with heavy and dense wood. The trees are evergreen in subtropics and tropics, but deciduous and broad leafed in temperate. The hardwoods can also be subdivided further into very heavy, heavy, medium heavy and ironwoods (woods that sink in water). Hardwoods are mainly angiosperms (flowering shrubs and trees) and their wood has water conducting cells that are referred to as vessel elements and tracheids. Moreover, the fiber cells are thick walled and tightly packed unlike in conifers. Conifers such as firs, pines, redwood and spruce are softwoods because they bear tracheids and lack fiber cells. Wood hardness is dependent on cell wall lignin, cell density and the proportion of pores in the cell wall. Popular hardwood species include cherry species, walnut, hickory, maple and oak. In the United Kingdom, hardwood trees are characterized by wood durability and hardness, and they comprise of Robinia, walnut, beech, oak, elm, ash and sweet chestnut. They are widely used for millwork, moldings, furniture, cabinets etc. Hardwoods species are greater in number than softwood species. In addition they are more expensive than softwoods. They are denser and have greater volume and calories than softwoods. They are highly preferred for projects where beautiful graining and strength is a prerequisite. *Quercus pedunculata* is a common oak in Britain and the

Scotland lowlands whereas *Quercus sessiliflora* is less common but frequent  
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in Northern England and Wales. Oak wood is the most durable and strongest amongst the timber trees in the United Kingdom. However, it's not favored for planting due to slow growth. Oak trees are largely grown in the national forests by the governments of England and France. Oak is widely used in machines, furniture, ships and houses. Thus oak is the most preferred hardwood tree for planting. Softwood Timber is wood derived from gymnosperm tree species. Unlike hardwood, softwood is not porous and is generally less dense. Softwood trees are evergreen trees and mainly comprise of conifers such as cedar, pine, Douglas fir etc. The wood is easily cut and has a wide range of uses e. g. furniture, building frames, chipboard, windows, staircases, doors, and paper. Coniferous forests also referred to as boreal or taiga forests are in the Southern hemisphere and are also common in North America, Asia and Europe. 80% of the timber used in the world is soft wood. According to the British Forestry Commission, there is sufficient supply for softwood for both current and future use. This largely attributed to extensive planting of conifers from 1960 to 1990. Thus the supply of timber is at its peak with the trees attaining maturity. This is well reported in Great Britain's National Forest Inventory reports i. e. ' 25-Year Forecast of Softwood Availability' and ' 25-Year Forecast of Standing Coniferous Volume and Increment'. The two reports reveal that the forest conifers range from 21 to 60 years old. Most important they will be viable for commercial harvesting in the subsequent 25 years (Rae, 2009). Thereafter, the supply of softwood may not satisfy the demand as relatively fewer conifers have been planted in Great Britain from 1990 to 2010.

2. 2. 2 Benefits of timber in construction Timber is ranked as the world's most eco-friendly building

solution. It is not toxic and chemical vapor is not leaked in the building. It <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>

ages naturally and is not degraded into toxic products that is environmentally damaging. In addition, timber is renewable as its continually grown in plantations and forests. Relatively little energy is utilized in the conversion of wood to building timber. Energy in timber is the lowest in all building materials. Timber also serves as a good reservoir of atmospheric carbon that contributes to global warming. It is also a good insulator and this reduces the use of energy in heating buildings. Energy costs are reduced in winter and the buildings are cooler in summer. Energy needs are generally reduced when timber is used in the construction of floors, doors and windows. Timber is also readily available and has made a big impact on local economies. A wooden structure takes a short period to construct and yields a fast financial return. Moreover, the construction of a timber building is not subject to weather conditions. There is high thermal value/wall width as compared to other construction forms. The construction is lighter and this reduces the cost of the foundation.

### 2. 2. 3 Properties of Timber

The properties of timber vary depending on direction. The strength is high when it is parallel to the grain, but it is low when it is perpendicular to the grain (Punmia, Jain and Jain, 2005). Tensional strength is 40 times higher when the wood is parallel to the grain as compared to when is perpendicular to the grain. Thus it is easier to split wood along its grains/fibres than perpendicular to the grain. Timber is hygroscopic and its moisture content varies depending on climate. If the moisture content is lower than 30%, the shrinkage of timber is perpendicular to the grain, but the shrinkage experienced along the grain is negligible. The cross-section planes can experience 7% shrinkage. The moisture content of timber should be maintained at equilibrium similar to that of the product. In service, shrinkage deformations lead to tension on

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planes perpendicular to the grain and this presents a major failure. Owing to varied shrinkage in tangential and radial directions, there are splits when large planes of timber are dried rapidly. Kiln drying minimizes the incidence of splits.

## 2. 2. 4 Timber decay

### Causes of wood decay

Moisture and sap in wood. Moisture and heat. Alternate wet and dry conditions. No ventilation

### Rot

is the most common wood decay and is largely caused by microbes or chemical processes which are responsible for putrefaction and decomposition which is accompanied by the evolution of gases such as carbon dioxide and hydrogen sulphide. They are 2 types of rots: wet rot and dry rot.

### Wet Rot

This is chemical decay that leads to decomposition of timber tissues, and is caused by alternate wet and dry conditions. The timber that is used for exterior works (e. g. windows, doors etc.) is highly susceptible to wood rot. The affected timber is degraded to grayish brown powder. This is prevented by using seasoned timber that is covered with paint or tar for both ground work and exterior work (Punmia, Jain and Jain, 2005).

### Dry Rot

This mainly attributed to fungi and the most common fungal species is *Merulium lechrymans*. The wood is also degraded to powder (Punmia, Jain and Jain, 2005). Dry rot initially sets in the sap wood. The fungi breakdown the wood, it becomes brittle and the fibers have reduced cohesion before the ultimate degradation into powder. Fungal grows and proliferates when there is no ventilation. Poorly seasoned sap wood is highly susceptible to dry rot stored in warm damp conditions lacking ventilation is susceptible to dry rot.

Favorable conditions for dry rot include: warmth, presence of sap, dampness, absence of sunlight and stagnate air. Dry rot is prevented by using seasoned timber that is devoid of sap. In addition, timber should be kept dry in places with adequate ventilation (Punmia, Jain and Jain, 2005). Wood is also

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attacked by insects mainly white ants, marine borers and beetles. 2, 2. 5

**Testing Timber**The commonly tested properties of timber include: tensile strength, moisture content, specific gravity, compressive strength and shrinkage & strength (Punmia, Jain and Jain, 2005). **Moisture Content**The test specimen should have a size of 50 mm × 50 mm × 25 mm of the entire specimenTake mass M1 of the test specimen. The specimen should be oven dried until it has a constant weight at a temperature  $103 \pm 2$  °C and take M2 of the test specimen.  $\text{Moisture content } m_o = \frac{M1 - M2}{M2} \times 100$ **Shrinkage Test**The test specimen should have a size of 50 mm × 50 mm × 150 mmUsing the immersion method, V2 of the specimen should be takenThe end of the specimen should be dipped in hot paraffin and left to air dry until the specimen has a moisture content ranging from 12% to 15%. V2 of the specimen should be taken again via the immersion method. Volumetric shrinkage can be computed using the following formula  $\text{Volumetric shrinkage} = \frac{V1 - V2}{V1}$ **Compressive strength test**The specimen should be prism shaped with a height of 30 mm and base of 20 mm. The specimen is gradually loaded into the compression testing machine. The failure load P is recorded.  $\text{Compressive strength} = \frac{P}{A}$  N/ mm<sup>2</sup>AA is the test specimen's cross-section area**Compressive strength perpendicular to the grains** is lesser than parallel to the grain. **Tensile strength test**A test specimen of 50 mm × 50 mm × 200 mm should be prepared. A tensile load is applied either perpendicular or parallel to the grain. The maximum load P is noted at failure.  $\text{Tensile strength} = \frac{P}{A}$  N/ mm<sup>2</sup>AA is the test specimen's cross-section area**Tensile strength parallel to the grains** is greater than perpendicular to the grain. 2. 2.

6 **Timber Fire Proofing**Timber can be treated in order to render it fire

resistant to a considerable extent. This is through covering it with a material  
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or compound (Punmia, Jain and Jain, 2005). This is done using superficial layers and coatings of the preferred protective material on the timber surface. The coatings reduce the usual temperature increase during fire incidences thereby decreasing the rate at which the flame spreads. The flame penetration rate is also lessened as well as the timber surface in contact with fire. These coatings are only viable for interior purposes as they wear out upon exposure to the weather. The fire retardant water soluble chemicals are mainly a formulation of borax, sodium silicate or ammonium sulphate mixed with other materials with qualities that promote color, appearance, brushability and timber adherence. Chlorinated rubber is a protective layer that can be used as well as other fire retardant chemicals such as chlorinated paraffin or zinc borate. Secondly, timber can be impregnated. Complete impregnation is done with chemicals that render the wood incapable of combustion. Partial impregnation may be sufficient but inappropriate if the wood is supposed to undergo milling. The chemicals comprise of dibasic ammonium phosphate, monobasic ammonium phosphate, sodium tetraborate (borax), zinc chloride and boric acid. Ammonium phosphates inhibit glowing and flaming. Borax inhibits flaming but does not retard glowing. Boric acid inhibits glowing but does not retard flaming effectively. In Burnett's fire proofing process, timber is soaked in a mixture of water and zinc chloride. In Abel's fire proofing process, a dilute sodium silicate solution is painted on timber followed by a cream of slaked lime, and finally a concentrated solution of sodium silicate (Punmia, Jain and Jain, 2005). Chapter 33. 1 Steaming Timber Timber can be steamed to increase its performance in terms of resisting fire and improving its appearance. Steaming is also important in manipulating timber so as to

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acquire the desired shape without losing the properties of the timber such as its strength (Johnson, n. d). During the steaming procedure, a frame of wood is placed in the wood vessel for several hours and steamed. After steaming, the wood is then removed from the vessel and held in a mould till it dries.

Wood can be steamed using five major approaches that include steam bending, laminate wood bending, kerfs' cut bending, microwave steaming for smaller pieces in addition to cold bending and dry bending. The kerf-cutting method is executed through cutting slots along the stick to be bent and compressing together to allow the wood to bend. The slots are usually cut to the insides where the wood is needed to bend (Hoadley, 2000). The microwave steaming method of bending uses small sticks in the bending process. Here, the sticks to be bent are either wrapped with a wet paper or a towel. Thereafter, they are microwaved for a short period of time usually several seconds. However, the microwaving period depends on the condition of the wood with respect to moisture and thickness of the pieces. Additionally, the microwave is also a determining factor of the microwaving period. Broken frame are common in this procedure and usually caused by improper engineering and age of the wood. Cold bending is not very popular and similar to dry bending it is widely used in the far East of Asia. In this method, cold water is applied repeatedly to the wood until it becomes soft enough to be bent (Schleining, 2010). There is a high probability that bending will fail if small curvature bending approaches are used. This implies that applying components with a greater radius usually provide a greater probability of a successful bending. It is considered a wise idea to use a ladder or the rear of a chair. Additionally, it is recommended that an individual applies heat after bending although not a necessity. However, there are other minor

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approaches that can be used to bend and soften the wood that include heating the wood while wet, which makes use of the existent moisture in the wood. Additionally, the use of boiled water that is useful in penetrating the fibers of the wood has also been regarded as an alternative in addition to using chemicals to bend the wood. The difference between these bend techniques include the quality of the result. Most hardwood types bend better as compared to the softwood counterparts. However, the most popular method of bending is steaming as it even maintains the quality of the output product. This method is still being used today in the United Kingdom and has for a long time been used to make boats as they represent some of the output products that require bent wood. During steaming, the wood is steamed for long periods where one inch thickness is steamed for approximately one hour. The steaming period depends on the type of wood being steamed as some require longer periods than others. When the steaming is completed and the desired shape is realized, the wood must be held in a mould otherwise the user might be required to hold the wood for long periods until it dries. Despite this method having been trusted for centuries, there are other techniques used in increasing the strength of the wood such as sistering. Sistering is a traditional method that reinforces both sides of the wood being steamed. One side is referred to as a sister. " One side (sister) has another frame laid partially next to it, and the frames are glued, bolted or sometimes screwed together". In this method, the size of the wood or its length does not matter, which implies that it can be glued or bolted. The major advantage of using sistering is that it is a reliable method in repairing frames especially those used to make boats. The curve of radius can be held using a small piece of wood. Nevertheless, the method of

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sistering has several major disadvantages. First, the screws used during the process of sistering may cause the frame to lose strength by creating holes. Steam bending requires more time than any other method of bending the wood. It requires more time than even the method of glue laminating. Some of the equipments used in steaming include basic steamers, wallpaper steamer or a kettle. Despite this method being effective, it is hazardous to the users or the practitioners. The procedure is only attempted by experienced practitioners as opposes to the glue laminating method. Additionally, as precautionary procedures, thick heat resistant gloves should be worn prior to the exercise. The whole procedure is also determined by the type of wood being bent in addition to the dryness of the wood and its thickness. Small sticks are easily bent and straightened over heated soap stone. Although the steaming procedure is effective in bending, it includes other problems that are not present in other procedures like glulam. Such problems include overheating of the wood which could result in undesired results such as brattling of the wood. However, it is not easy to maintain the heat at the required temperatures as it is easy to bend the wood using other procedures like glulam. It is also not easy to ensure that the inside of the wood is softer than the outside for a successful bent to occur. Choosing the wood to be steamed is also not easy because the wood to be bent must be absolutely parallel with the growth of the tree otherwise it might break while during the bending process (How to Make Wood Bend, n. d). This is not of great importance while using the glulam because the woods that are not parallel can be forced to bend using bolts and other equipments. The glulam procedure makes use of most the available wood as opposed by the steaming method. Extreme care must be taken while using the steaming

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method because it requires long periods of steaming to make the wood pliable enough to bend as per the requirements (Johnson, n. d). If inadequate steaming is done, the wood might suffer permanent damage as a result of breakage during the process. As the idea of steaming the wood is to enable the user to bend the wood without breaking it, there are several reasons why the wood might break whilst in the steaming process (Blaustein, 2008). If the wood being used is too dry, it may be difficult to get it soft so as to bend it. In addition, due to the fact that certain types of wood can bend up to a certain angle or curve, forcing a different type of wood beyond the possible curve might cause it to break and cause permanent damage to it. The wood might break if it was not adequately heated or it were not straight enough (Wood Bending and Forming, 2005). This implies that many factors must be considered and the wood to be steamed chosen wisely if the procedure is to yield the anticipated results. To prepare for the procedure an individual requires a reliable heat source, a hose to carry the steam to the steaming area, a container to store the heated water and fitting screws. A kettle can be used to hold the hot water. These requirements may be required in different lengths depending on the length of the wood to be bent. For instance, the pipe is cut according to the length of the wood in addition to the fittings sizes (Johnson, n. d).

### 3. 1. 2 The Steaming procedure

The pipe to transport the steam is glued from either side and a single hole created to allow the steam to escape. If the holes are not made, the pipe may burst. Two additional holes are made at approximately five inches apart and a stainless steel bolt pushed through the steam pipe. This preparation allows the wood to be on a suspended position during the procedure and not be in contact with the pipe (How to Make Wood Bend, n. d). This enables the

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steam to penetrate the wood from all sides making it possible to steam adequately. To avoid marking the wood during the procedure, it is essential to keep the metal away as much as possible to avoid contact. The holes should be on the correct size in that they should not be too wide or too narrow and must be sealed with silicone.

3. 2 The laminated wood bending or glulamGlue laminated timber also commonly referred to as Glulam, is an advanced and versatile construction material used in both commercial and domestic construction projects. The major applications for this product include increasing design values in addition to ensuring improved product functioning (Timber Structures, 2009). Perfect performance enabled by this product improves its market competition against other products. The product is also product competitive besides being high quality. Glulam can be used in construction of simple beams to soaring arches used in stadium roofs extending above 500 feet. Glulam composition consists of carefully chosen wood laminations also known as lams in addition to moisture tolerant adhesives (Pizzi, 2006). The wood laminations are selected as per their performance characteristics and bound together using the moisture tolerant adhesives. The complete product of glulam is available from depths of 6 to 72 inches or even greater lengths of up to 100 feet. The general idea behind glulam is the visible beauty and hidden strength where an adhesive is used to bond pieces of timber to be used in utilitarian and decoration purposes. North Americans refer to the laminating material as lamstock or laminating stock. Glulam offers added advantage to the builders because it is abundantly strong and stiff (Law, 2005). Additional, the material is stronger than steel on pound basis. The connections on glulam are made using bolts or steel dowels supported by steel plates making it strong enough to hold

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massive weight. The material also provides the best surface quality, which enables a wide range of application options in the construction area. Glulam can be used in both straight components and when curved. This gives the material a unique characteristic that makes it favorable from other options. Glulam can be used in many construction areas that include tied rafters, tied arches, curved portals, curved beams and glulam trusses. The usage of glulam in the modern world is the advanced version of the traditional techniques used in the same that were developed during the 20th century. The process of glulam was first applied at the end of the 19th century in Switzerland. The original name used for it is Hetzersystem. The glue laminated timber use increased during the Second World War when construction of military buildings, military aircraft hangers and warehouses was required in large. The process of glue lamination must follow specific standards so as to justify the precise or the perfect design. Typical products produced through the process of glulam include domes, arches, girders, beams and rigid frames. The process is a major concern while constructing wood connections as it connects the wood together perfectly. So as to come up with a perfect connection between the timbers, the designer must carefully consider on how to accomplish a smooth and desirable connection. " laminated beams were used in the middle of the first engineered wood products shaped from boards or plank spiked or dowelled together, as were found in early ships, bridges and building construction". During the Second World War, the resin glues were developed and production knowledge based on these products improved to make the industry flourish. The machinery used to produce glulam products is capable of producing structural member layers, which are larger than those that other plants can produce (Blaustein, <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>)

2008). Practically, the glulam production machinery can produce as long and wide products as can be handled. Through laminating several small pieces of timber, a larger and a stronger structural member is produced and are usually applied as vertical columns, arching shapes, curved and horizontal beams (Aghayere & Vigil, 2007). The horizontal columns are usually made when several pieces of timber are glued to form a single structure unit. The vertical counterparts are made when the laminations are at right angles to the natural pane. Here, the glue lanes are perpendicular to the length of the cross section. The strength of these products is usually enhanced through using a reliable binding material and reinforcing using steel plates and bolts (Blaustein, 2008). Due to the fact that large timber uses have caused environmental worry, efficient usage of available wood has been emphasized and the process of laminating this wood to produce bigger products has enabled the usage of almost all the timber available for construction (Timber Structures, 2009). Here, the glulam products are made from less attractive timber to make other stronger products that are stronger than other products made of solid timber. The products from glulam are advantageous as compared to other products made of solid timber in several ways. First, the glulam products suffer less from defects as compared to timber products that develop many defects as a result of weather or moisture changes. The products of glulam are environmentally friendly as compared to other products such as concrete or steel products because they have minor energy requirements (Bostrom et al. 1999). Although this procedure also requires the user to apply many considerations, it is much easier and safer than the steaming method. Thin pieces of wood are used in this procedure. " In this method, some of the length will be trimmed after the process. It is best to <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>

ensure there is an additional 1/8 inches on the length as it will be easier to bend. Sometimes pieces are glued together and used. After the form or mould is ready, glue is spread on the pieces and they are stacked together in the form of the clamp". After the glue dries, the edges are trimmed. Glulam is made from both hard and soft woods species (Hermawati, Massijayaand, Nugroho, 2010). Some of the most common species used in this mode of bending wood include the Dauglas FirLarch, the Alaskan Yellow Cedar as well as the Southern Pine.

### 3. 2. 1 Classification of Glulam products

Glulam products are classified according to strength. The stress class system includes the soft wood glulam combinations. Glulam has four main appearance grades as included in ANSI A190. 1 (2002). The horizontal glulam is the only product classified. It is then classified as either homogeneous or combined. The homogenous type refers to the laminated timber with lamination sections that are on the same grade in their entirety (Hermawati, Massijayaand, Nugroho, 2010). The combined version is the type of lamination where there are different types of laminations in the inner and the outer sections. The most common choice for home building purposes is the framing appearance grade. This mode is only recommended for usage in concealed areas. The industrial grade appearance form of glulam is applied on areas where aesthetics is not a major issue. The appearance of the industrial grade is better finished as compared to the framing grade. This is usually applied in areas that are not visible to the public. This is because this mode shows wood imperfection on the surface including knots and voids. The architectural grade is the most preferred when applying glulam as the exposed element in structures (Forest Products Laboratory (U. S.), 2007).

This product shows a highly finished glulam product because the wood voids  
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and imperfections are treated or filled so as to enable the exhibition of an architectural surface with a good surface. The premium version is used on special occasions especially in places where high concentration of individuals is anticipated (Laminated Timber Architecture, n. d). The premium glulam is used on such occasions because it has smooth surfaces that result in a high quality end product (Structural Glued Laminated Timber, n. d). Glulam products that are pressure treated are used in such areas in addition to timber products that have been manufactured using naturally durable Glulam has many benefits that include providing a highly durable material and having a perfect insulation properties as compared to other products. Additionally, the product is customizable to fit every customer's special construction needs as well as providing a material that is easily installed and repaired (Laminated Timber Architecture, n. d). In addition, the finished product is lighter than other products such as steel. The finished glulam product is approximately one sixth lighter than concrete beams of the same dimensions. For this weight advantage, the finished product ensures low transportation cost as well as handling costs. The material can also be made in large sections and long lengths. The advantage that makes it attractive in the market is its resistance to fire (Timber Structures, 2009). Here, if glulam and steel beams are put in similar fire conditions, glulam product would survive the situation better than steel would. This advantage reduces the risk of fire spreading fast therefore being highly advantageous. However, glulam products require care while handling. While lifting the products, the fabric sling should be used. Using chains to lift the products would damage the finished smooth surface. The finished product should be stored vertically and covered using plastic sheeting to protect it from weather. Unless the <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>

product is intended to be used in exposed areas, it should be protected until installation. In the construction of bridges, durable wood species are used such as the Alaska Yellow Cedar as it has the capability to produce beautiful and the required strength to hold the massive strength (Laminated Timber Architecture, n. d). This is because wood has the ability to absorb shock and impact forces produced by the traffic. Wood has a property that makes it favorable for road constructions that include de-icing agents where it resists effects of such chemicals.

### 3. 2. 2 Manufacturing of glulam

The process is carried out by skilled tradesmen who have the necessary tools and equipments to execute the procedure. Before the procedure starts, the surfaces to be glued are first cleaned to ensure that they are free of dirt, dust or saw dust for maximum effect of the laminating material and for perfection (Frechette, 1999). It is recommended that the surfaces be glued within 48 hours after they have been cleaned to prevent the possibility of having more dust rest in it. Additionally, the surface of the timber to be used is required to be flat and any possibility of roughness should not exceed 0.015 inches in either depth or height. The moisture content is also checked. At the time of gluing, BS EN 386 requires the moisture content to be within 3% to 15% but should not exceed 15% or go below 3%. This moisture is required while bending. In addition, the moisture content of other pieces of timber to be used in the process should not differ by more than 6% implying that all pieces to be used should have a moisture content of 6% with each other. During gluing, the joints are brought into close contact with each other by applying pressure to them. This contact should be maintained throughout the gluing process (Tannet, Muller & Vallee, 2010). Then a conditioning period is a necessity because some adhesives do not gain utmost strength

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during the curing or the gluing period. If the glue used in the process is squeezed from the edges while pressure is being applied, it indicates that the glue is still wet (Stalnakar & Harris, 1997). The adhesive material to be used in the binding should be applied according to the manufacturer's instructions. " It should be evenly applied to both surfaces forming the joint at an amount not less than the minimum quantity of joint area double spread, as recommended by the manufacturer for the type of joint and for the species of timber being used". Despite the fact that laminating appears as an easy job of sticking pieces together, it could run into a ruin if proper precautions are not taken. The procedure should only be undertaken by trained and qualified laminators to prevent the occurrence of replacements which are usually expensive. Replacement cost is a serious situation as it can even lead to financial ruin and bankruptcy of the company (De Luca & Marano, 2011). Therefore, extreme caution should be undertaken and appropriate and adequate qualification acquired prior to starting producing. However, the laminators do not have to be structural engineers but should have minimum qualification in this field that includes having elementary understanding in engineering as it is essential. Additionally, the laminator should be in a good position to interpret drawings. These requirements would ensure that the individual can practice high level manufacturing standards (Janowiak et al. 1997). The development of glulam depends on the correct usage of timber in addition to proper exertion of pressure and application of the correct amount of glue where these practices should be in accordance to the already established grading and classification rules (Structural Glued Laminated Timber, n. d). When the laminated timber is removed from the clamping system, the product should be polished to remove

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glue beads that squeezed out when pressure was exerted. This ensures the realization of a smooth product. The next stage involves additional finishing which dictates the look of the final product. This stage only enhances the look of the product but does not affect the strength of the timber in any way. The final step involves making of hole and cuts as per the customer's request. A sealer could also be applied as per the anticipated function of the product. The finished glulam has a fire resisting property where the wood resists catching fire after long periods of exposure to fire and if it does catch fire it burns very slowly due to the binding property and additives include during the manufacturing process (Timber Structures, 2009). The insulation layers formed on the surface of the surface inhibit the fast spread of fire. During a fire, the glue laminated timber begins losing its strength slowly but because of the large extension of the product, it takes longer to lose all its strength that steel would. This is another advantage of the laminated timber over its counterparts (De Luca & Marano, 2011). The steaming procedure of bending the wood does not add the property of fire resistance making glulam a competitive choice in the market even better than steel can do. Technically, there exists no construction material that is completely fireproof. The difference in construction materials is that some can catch fire fast while others deform in an instance of fire such as metals (Aicher & Reinhardt, 2007). Additionally, concrete may crack or spall during a fire. Glulam materials continue in this trend in offering a product that takes longer to catch fire reducing the rate at which fire spreads making it favorable in comparison to solid wood that catches fire incredibly fast and disintegrates to ash at a faster rate. Another advantage with glue laminating timber is that it becomes highly versatile (Timber Structures, 2009). This <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>

implies that timber can be manipulated to form various shapes at different sizes as required. Glulam products can form different shapes ranging from curved arches to straight beams. This exceptional structural adaptability of glulam enables wood to extend its qualities to varied applications as required by the designers (Rice et al. 2006). Although glulam is commonly used in column functions, it is also applied in window and door headers as well as ridge beams. Additionally, glulam allows timber to extend its quality and strength as well as its length and size (Petersen & Solberg, 2005). Its exceptional strength and stiffness makes the product the ideal choice especially when constructing lengthy structures such as the long span girders (Timber Structures, 2009). The highest grades of wood are used in the most stressful areas while the lower grade wood is used in less stress areas. This improves the ability of the structure being constructed to become exceedingly strong. Stress in construction structures are usually high to the top and the bottom of the structure implying that the high grade wood is used at these positions while the lower grade ones are applied at the core. This strength allows the glulam products to have a lengthy span without requiring columns to support them. The major factor that limits the span of glulam products is transportation in addition to handling requirement (Timber Structures, 2009). The use of a number of lamination options reduces the timber's variability and improves its strength where strength is the major advantage offered by glulam products. Moreover, it is entirely possible to manufacture sophisticated sizes and shapes of beams and columns. The manufacturer can also manufacture any size according to availability of transport. Furthermore, the ratio relationship between the size of the product and its weight is excellent in that the application of glulam

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procedure allows the manufacturing companies to manufacture lengthy products that are not as heavy as their steel counterparts with similar span (Timber Structures, 2009). Additionally, besides being able to make such highly manipulatable products, the products also offer other properties such as fire proofing and stiffness (Laminated Timber Architecture, n. d). Glulam products are also dependable (Laminated Timber Architecture, n. d).

Although glulam is not as historic as steam bending, it has been used for more than 100 years in some continents such as Europe (Wood Bending and Forming, 2005). The AITC certification of 1961 was for a long time responsible for ensuring safety, production of high quality glulam products and assurance of long lasting product production (Laminated Timber Architecture, n. d). The AITC is based on three major quality control elements that include licensing the manufacturers, maintenance of quality control and frequent inspection of production plants to ensure that safety standards are kept. Using wood in construction offers many advantages (Lam, et al. 2006). Wood is one of the products that require little energy implying that it reduces the usage of fossil fuels. This makes it environmentally friendly.

Wood has a natural insulating property that is many times better than steel and concrete that makes it possible to use little energy in heating or cooling the structure (Laminated Timber Architecture, n. d). The other advantage is that wood is biodegradable as opposed by other products such as steel or concrete products. Additionally, wood is renewable.

### 3. 3 Comparing the strength of glulam to that of steamed frames

There are many properties that make timber the ideal choice for being the raw material in glulam products that include its ability to form many shapes and producing a fine and an attractive product (Wood Bending and Forming, 2005). This is enhanced by <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>

combining it with other products. For many years, the types of products to be used in glulam products depended on empirical or trial and error experimentations according to purposes and hazards. The process of glulam requires two major components that include timber and adhesives while the steam procedure requires timber and bending equipments. Here, both the procedures require hard work and either approach is chosen to produce a reliable and a customizable beam and a frame (Tannet, Muller & Vallee, 2010). The difference comes in when comparing their products in terms of strength and span. Glulam can make a wood product as big as can be transported. The steaming option does not produce as large options as the glulam. The glulam option is easier to accomplish and not many requirements are required. In addition the risks involved while bending the wood are few as compared to the steaming method, which is prone to errors of breakages (Aicher & Reinhardt, 2007). The glulam option makes use of adhesive while the steaming option requires a source of steam and an equipment to help in the bending. The glue lamination procedure requires some pressure to be used in binding the wood and some bolts to hold the bonded wood together. Undoubtedly, the glulam option is able to produce a stronger structural product than steaming (Camille & Kmeid, 2005). Safety is a major concern and difference between these options. The glulam method does not require much safety concern but the steaming option does. An individual could get burnt when setting up the procedure with the hot water. In terms of popularity, glulam is more popular than the steaming method. However, steaming method is more historic than the glue laminated method. The difference in popularity is brought about by the time required to complete a process. Steaming method requires a very long time and has <https://assignbuster.com/history-of-timber-in-construction-construction-essay/>

higher risk of failure than the glue lamination that takes shorter period of time. Glulam is also used in almost all constructions and mostly applied when designing big hall and bridges that require a large span of material. Moreover, this option is also applied when constructing ships and boats. This implies that steamed frames are less likely to be used in such large constructions. The steamed option is largely used while doing in-building constructions. Such areas include construction of staircases. The steamed option can also be used while making in-door furniture and when making small boats. The major setback on the steamed frames is that the steamed frames are more expensive as compared to the glulam. The steamed piece of wood takes more time to deliver as compared to the glue laminated timber. However, the glulam products are more demanding in that they are prepared in a variety of sizes, shapes and grades. After the manufacturing of glulam products, appropriate tests must be carried out to confirm that the products meet the expected manufacturing standards. In glulam, at least 20% of the whole production should be tested to confirm the standards. The steamed frames also require testing. In the steaming procedure, testing is carried out to determine the following. First, the test must verify that the whole steaming procedure has been executed appropriately. Second, it is also examined whether appropriate care has been taken to ensure that the wood would not break whilst in the process. Third, the test procedure also confirms that the wood was not too dry during the time of steaming to prevent future problems. Forth, the test is also responsible for sustaining the fact that the wood has not been attempted to be bent beyond the curve that it can take. Lastly, the wood is also tested to ensure that the wood grain was straight enough and that the wood was adequately heated during the

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process of steaming. These factors must be assessed to ensure that the wood will not brittle while in the bending process. This shows that the steaming process requires many tests and confirmations even before the process of bending. These are the main reasons why steaming is not as popular as glulam and as preferred in the market as the latter.