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A COMPARATIVE CALCULATION BETWEEN THE TIMBER FRAME CONSTRUCTION AND THE MASONRY CONSTRUCTION.

Orynbek A.D.[1] Jumabayev A.A.[2]
orynbekakmor@gmail.com , atagali@list.ru
[1,2] L.N. Gumilyov ENU, Astana, Kazakhstan;
Scientific supervisor - A.A. Jumabayev

Introduction

The construction industry has been developing rapidly over the years, with various materials and techniques being utilized for the construction of buildings. The use of timber and masonry materials for building construction is common, and they provide unique advantages and drawbacks when used in construction[1]. The purpose of this study is to investigate the properties, advantages, and disadvantages of timber frame construction and masonry construction.

Construction is an essential aspect of human life. It has been in existence since time immemorial. The construction of houses, buildings, and other structures is necessary for civilization. There are several methods used in construction, and this paper seeks to conduct a comparative analysis between the timber frame construction and masonry construction.

The comparative analysis of timber construction and masonry is a topic of great importance in the field of construction engineering. Both methods of construction are widely used and have their advantages and disadvantages in terms of structural strength and rigidity. In this article, we will carry out a comparative analysis of the two methods, along with calculations for strength and rigidity.

Advantages of Timber Frame Construction:

1. Speed of construction – Timber frame construction can be built quickly, thus reducing the construction time.

2. Cost-effective – Timber is less expensive compared to other materials used in construction, hence reducing the cost of construction.

3. Environmentally friendly – Timber is a renewable resource, and the timber frame method uses a minimal amount of materials, making it environmentally friendly.

4. Energy-efficient – The insulation in timber frame construction is superior, ensuring that the building is energy-efficient.

5. Design flexibility – Timber frame construction can be designed to meet different architectural requirements[2].

Disadvantages of Timber Frame Construction:

1. Fire hazard – Timber is flammable, and this poses a fire risk to the building.

2. Moisture damage – The use of timber in construction can lead to moisture damage, which weakens the structure over time.

3. Limited span – Timber frames can only support a limited span, and this may limit the design of the building.

Advantages of Masonry Construction:

1. Durability – Masonry offers a long-lasting solution, making it ideal for buildings that are expected to last for many years.

2. Fire-resistant – Bricks and stones are fire-resistant materials, making masonry construction safe in case of fire breakouts.

3. Low maintenance – Masonry construction requires minimal maintenance, which reduces the costs associated with the building's upkeep over the years[3].

Disadvantages of Masonry Construction:

1. Cost – Masonry construction is more expensive compared to timber frame construction.

2. Slow construction process – Masonry requires more time to construct the building, which is a disadvantage.

3. Limited design flexibility – Masonry is inflexible, and this limits the design options available for the building.

Cost Implications:

The cost of timber frame construction is cheaper than masonry construction. Timber is a renewable resource that is readily available, making it cheaper as compared to masonry. The construction process for timber frame construction is quicker than masonry, which reduces labor costs.

Environmental Impact:

Timber frame construction is environmentally friendly because it uses renewable resources. The timber used in the construction process can be sourced from sustainable forests, making it environmentally sustainable. Alternatively, masonry construction uses non-renewable resources, leading to environmental degradation.

Methods

Timber construction is a popular method of construction for buildings up to four stories. It is also widely used for the construction of single-family homes. The construction technique uses timber as the primary building material[4]. The timber is made up of a series of vertical and horizontal members, called studs and joists, respectively. The walls, floors, and roofs of the building are then assembled by attaching sheathing and insulation to the frame.

Strength and rigidity of timber construction

The strength of a wooden structure is directly related to the type and quality of the wood used. Generally, softwoods such as pine or spruce are used for framing, while hardwoods such as oak or ash are used for decorative applications. The rigidity of the structure depends on the size and spacing of the studs and joists. A greater number of studs and joists can increase the rigidity of the structure.

The formula for calculating the bending stress on a wooden beam is:

$$\sigma = (M \times y) / I \quad (1.1)$$

Where σ = bending stress, M = moment, y = distance from neutral axis to outer fiber, and I = moment of inertia.

For example, let us consider a timber with a length of 3 meters, a width of 10 centimeters, and a height of 20 centimeters. If the load applied to the beam is 5 kN at the center, the bending moment will be:

$$M = (5\,kN \times 1.5\,m) = 7.5\,kNm$$

The moment of inertia can be calculated as:

$$I = (b \times h^3) / 12 \quad (1.2)$$

Where b = width of the beam, and h = height of the beam.

$$I = (10 \times 20^3) / 12 = 13{,}3\,cm^4$$

The distance from the neutral axis to the outer fiber (y) can be taken as half of the height of the beam, which is 10 cm.

Substituting these values in the formula, we get:

$$\sigma = (7.5\,kNm \times 10\,cm) / 13{,}3\,cm^4 = 0.05625\,N/mm^2$$

Masonry construction involves the use of materials such as bricks, concrete blocks, or stone to build a structure. The materials used are bound together with mortar to form a wall[5]. The advantage of masonry construction is its durability and resistance to fire, noise, and weather.

Strength and rigidity of masonry construction

Masonry structures have high compressive strength but low tensile strength. The compressive strength of bricks or concrete blocks ranges from 7 MPa to 50 MPa. The tensile strength is much lower, ranging from 0.5 MPa to 5 MPa. This is the reason reinforcement bars are used in masonry walls for added strength.

The formula for calculating the bending stress on a masonry beam is:

$$\sigma = (M \times y) / Z \quad (1.3)$$

Where σ = bending stress, M = moment, y = distance from neutral axis to outer fiber, and Z = modulus of section.

For example, let us consider a masonry beam made up of bricks with a length of 3 meters, a width of 25 centimeters, and a height of 20 centimeters. If the load applied to the beam is 10 kN at the center, the bending moment will be:

$$M = (10\,kN \times 1.5\,m) = 15\,kNm$$

The modulus of section can be calculated as:

$$Z = (b \times h^2) / 6 \quad (1.4)$$

Where b = width of the beam, and h = height of the beam.

$$Z = (25 \times 20^2) / 6 = 16{,}667\,cm^3$$

The distance from the neutral axis to the outer fiber (y) can be taken as half of the height of the beam, which is 10 cm.

Substituting these values in the formula, we get:

$$\sigma = (15\,kNm \times 10\,cm) / 16{,}667\,cm^3 = 0.9\,N/mm^2$$

Results

From the calculations above, it is clear that the bending stress on a wooden beam (0.05625 N/mm²) is significantly lower than that on a masonry beam (0.9 N/mm²), even when subjected to similar loads. This is due to the difference in the materials' properties, with wood having higher tensile strength than masonry.

Furthermore, the modulus of section for a masonry beam (16,667 cm^3) is much larger than that of a wooden beam (13.3 cm^4), indicating that a masonry beam has much greater resistance to bending.

Conclusion

In conclusion, while masonry construction has the advantage of durability and resistance to weather, its ability to withstand bending stress is limited. Wooden beams, on the other hand, may not be as durable as masonry but are able to withstand higher bending stress due to their higher tensile strength. Therefore, the choice of material for beam construction depends on the specific requirements of a project, such as desired durability and load-bearing capacity.

This paper has conducted a comparative analysis of timber frame construction and masonry construction. The analysis has identified the differences between the two methods, evaluated their respective advantages and disadvantages, analyzed cost implications, assessed environmental impacts, and made recommendations based on the analysis. It is evident that timber frame construction is the most favorable and cost-effective method of construction.

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ҚҰРЫЛЫС МАШИНАЛАРЫ ПАРКІНІҢ ҚҰРАМЫН ОҢТАЙЛАНДЫРУ

Өмірхан Іңкәр Ерланқызы
inkar.umirkhanova@bk.ru
Л.Н. Гумилев атындағы ЕҰУ Теоретикалық математика және ғылыми есептеу институтының ғылыми қызметкері, Астана, Қазақстан
Ғылыми жетекшісі – А.Р. Омаров

Құрылыс машиналары паркінің стандартты құрамының негіздемесі күрделі көп факторлы экстремалды міндеттер класына жатады. Бұл көптеген құрылыс машиналары, тракторлар, жүк көліктері, бульдозерлер, крандар және т.б. әртүрлі жағдайларда көптеген жұмыстарды орындай алатындығына байланысты және олардың әрқайсысында бірдей жұмыстарды орындайтын, бірақ басқа экономикалық нәтижелермен бірнеше "бәсекелестер" бар. Сондықтан, көбінесе оңтайлы пайдалану жоспарлары мен техникаға деген қажеттілік жұмыстың жылдық көлемін орындауға жұмсалған шығындардың минимумы критерийі бойынша жұмыс түрлерін оңтайлы бөлу нәтижесінде ғана табылуы мүмкін.