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Research Article

Comparative Analysis of Reinforced concrete, steel and Timber structures in modern construction Applications

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Abstract

Many professional Engineers in the field of construction make use of reinforced concrete, steel, and Timber for the design and construction of small, medium, and complex structures without considering the uniqueness of these structural materials. The lack of professional experience and ideas in the design of structural elements has resulted into making many structures e.g. Buildings, unfit for use during their service periods. Some structures that were designed with wrong materials ended up collapsing because of the materials selection for such structures. This paper examines the comparative analysis of Reinforced concrete, steel and Timber in modern day construction applications

Keywords: Comparative Analysis, Reinforced concrete, steel, Timber Applications

INTRODUCTION

The Ancient methods of carrying out construction of Buildings and other related structures were majorly of stones and carved woods into different shapes and sizes. As advanced Technology and civilization became known through the ages, the use of concrete, reinforced concrete, steel, and Timber also became the major construction materials apart from others for the construction of buildings, Bridges, Dams, Reservoirs, etc that provides comfort of mankind. With Advanced Technology and many years of research in science and Engineering, an improvement paved way for the applications of Reinforced concrete, steel, and Timber in modern construction, which is generally accepted worldwide, especially in construction industries. Though Reinforced concrete, steel and Timber are major construction materials, they are unique, have special functions, and positions they occupy in construction. This is what made them to be special, especially when considering the role they play when treating them as structural materials.

MATERIALS AND METHODOLOGY

The methodology adopted for this paper was a visit to some construction project sites in Omu-Aran, the local Government Headquarter in Kwara State, where there are many construction projects, especially Buildings are presently under construction. There are equally water Elevated tanks construction in some parts of the town, which are meant to supply water to many institution in the town. The structures that are covered under this paper are majorly designed and built in Reinforced concrete, steel and Timber which are generally structural materials. The photographs taken from various construction sites are the ones covered in this paper, and are also emphasized on under the discussion

Different types of Timber Roof trusses in construction

Different types of steel stanchions for Elevated water Tanks in construction

Different types of Steel Roof trusses in construction

Comparative Analysis of Reinforced concrete, Steel and timber structures

i) Reinforced Concrete

The plain concrete and steel in the form of bar is called Reinforcement. In this form, the full advantage is taken of the strength of concrete in the compression zones and of the reinforcement in tension zones of the structure. Though concrete is strong in compression, it is extremely week in tension. Its resistance to tension is so low that plain concrete can be where the member is in pure compression. Steel is equally strong in compression and Tension, but it is apparent that while steel can develop its full strength in Tension, it can not resist equal amount of compression force, owing to its buckling due to the slenderness. The combination of concrete and steel is called Reinforced concrete. Therefore, Reinforced concrete is a strong durable building material that can be formed into many varied shapes and sizes, ranging from a single rectangular column, to a slender-curved Dome or shell. Its utility and versatility are achieved by combining the best features of concrete and steel. A summary of these two materials is shown in table below:-

Table 1. Characteristics of Concrete and Steel

	Concrete	Steel
i) Strength in Tension	Poor	Good
ii) Strength in compression	Good	Good, but slender bars will buckle
iii) Strength in shear	Fair	Good
iv) Durability	Good	Corrodes, if unprotected
v) Fire resistance	Good	Poor- suffer rapid loss of strength at high temperatures

It can be seen from the above table that the two materials are more or less complementary. With their combination, the steel is able to provide the tensile strength and some of the shear strength, while the concrete being strong in compression protects the steel to give durability and fire resistance.

(ii) Steel structures

(a**) A steel structure is an assembly of a number of members**, such as trusses, root coverings, Beams, columns, Bracings, claddings, floorings and foundations, etc, that are usually proportioned to resist the applied loads and forces, vibrations, changes in climate conditions such as temperature, frost, and chemical attack. A steel construction is more reliable because steel is the only material whose behaviour is ideal. Steel construction has longest life span, of course with proper maintenance as compared to any other type of construction.

(b) Steel as the strongest of materials invented so far

It has been found to be the most ideal and reliable construction material in its behaviour. Available of steel in a variety of grades and shapes makes it suitable or economical framing of both short and long span structures. Steel offers economical design application for the rehabilitation projects and it can be easily modified, expanded or converted to suit future needs of owners and tenant.

(c) Steel is very strong in compression and in Tension

The members that are usually used in various structures are very slender and they also pose stability problems more than concrete structure.

(d) Steel economic

Extremely heavy load structure, large span structures or both and in condition of uncertainty, steel as an ideal material is very economical for use. In the construction of industrial building, workshops auditoriums, cinema houses, and also where large column free areas are to be covered, steel trusses system of roofing materials works are the cheapest to use. In addition, in railway bridges where heavy rolling loads are usually encountered, steel through type or deck type bridge are needed. Steel structures are preferred where large vibrations, temperature variations are expected.

(iii) Timber Structures

The principles on Timber structures, especially with design is the same with that of steel structures, except that the strength of a particular Timber has minimum strength when it is in green condition and it increases in strength as it becomes seasoned gradually. When the moisture content is reduced to 12 percent of the weight of the wood substance, the Timber is said to be seasoned and the strength increases. The selection of Timber either hardwood or softwood for any structural design depends majorly on such factors such as appearance, strength, moisture movements and dimensional stability, sizes, section, National durability and cost.

Construction Application Analysis of Reinforced concrete, steel, and Timber Structures

(1) Reinforced concrete structures

a) Urgent construction:-where urgent construction is required, the use of Reinforced concrete may not be applicable structure, such as multi-storey Building required enough time for the construction to be completed.
b) Finance: The cost of a project which includes materials and labour required serious construction and planning.
c) Maintenance;- Rusting is not a problem to structural element such as column, slabs and beams, because of adequate cover that is usually provided for the structural elements
d) Labour: The labour under Reinforced concrete construction can sometimes be locally obtained especially for simple and small structures
e) Designs: the design drawings can be drawn by an experienced draughts men or Architects for small Buildings.
f) The components for mixing concrete are locally available even in rural Area (i.e. Villages)

(ii) Steel structure

a) The components for steel are shop fabricated, and the erection is quite faster than that of Reinforced concrete.
b) The order (Request) for the purchase of steel for steel structure is usually put in place before time, so as to make all the necessary sizes available
c) Mistake during the design of structural steel and fabrication is more costly to amend. It usually required qualify professionals.

d) Labour and materials: - This is quite less than that of Reinforced concrete, and time is also less for completion. More money is usually save by using steel frames, especially for large projects.
e) Where corrosive materials like salts, Acids, etc are stored, the cost of maintenance is usually higher than that of concrete unless the steel members to be founded will be encased into concrete where the steel to be encase into concrete have No corrosive effects on steel, the maintenance costs will be less.
f) The construction of steel structure required experienced professionals, and may not be obtained sometimes from rural Areas (i.e villages)
g) Steel structures with adequate maintenance usually last more than that Reinforced concrete structures.

(iii) Timber structures

(a) Type of Trees: There are various type of trees, and the strength of different types are not the same. The codes of practice divides trees according to their strength as N1, N2, N3, e.t.c. how strong the trees are is dependent on the type of tree to be used for construction of structure. (e.g. roof trusses). Trees converted into Timbers are also grouped according to their strength. There are grades 40, 50, 60, 70, 80, 100, etc. grade 50 is for cabinet making, while grade 40 is for construction purpose.
b) Age of Tree: The younger the age of a tree, the weaker the timber that will be produced form it. Also, the older the tree, the stronger the timber as well
c) Defeats: Timbers are liable to different attack of defeats and insects before they are even converted from Trees. Such Timbers used for construction of structure may not last, except they are well treated before use.
d) Sizes of Timber: The deeper the section of timbers, the better it is, especially for bending. The shorter the span the better is the deflection that is to be experienced by the Timber.

CONCLUSION

The applications of reinforced concrete steel and timber structures in modern Engineering and Technology results in different areas of structural facilities for human's comfort and National development, can be seen every where within the country. The research and Technology that brought the applications of these materials into use is still on the discovery into more alternative designs that would produce better applications in place of Reinforced concrete, steel and Timber structures. The Engineering professionals, especially the civil and structural Engineers, and other related professional are also encourage to play active professional role in this area. This is one key factor that would lead the country into attaining world class in the area of structural designs and applications of Infrastructural facilities.

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