Comparative Design of AAC Block & Conventional Brick By Using STAAD-PRO & Manual Calculation

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***Abstract*— This paper presents the economics of autoclave aerated concrete vis-à-vis conventional brick. This project includes the analysis, design and estimates of structure, comparing between autoclave aerated concrete and conventional brick in the form of steel consumptions. Autoclaved Aerated Concrete (AAC) is a lightweight concrete building material cut into masonry blocks or formed larger planks and panels. Currently it has not seen widespread use in the United States. However, in other parts of the world it use has been used successfully as a building material.**

In this work we are comparing reinforced concrete design using autoclave aerated concrete and conventional brick as a construction material, as the weight of autoclave aerated concrete is much lesser than the conventional brick, by using this advantage we think, we can reduce the weight of infill wall on beams, columns, footings if conventional bricks replace by AAC block and simultaneously we can save reinforced steel.

Keywords:. Autoclaved aerated concrete (AAC), lightweight, conventional brick, reinforced steel, save and reduce.

I. INTRODUCTION

A. Importance and Necessity

Autoclaved aerated concrete (AAC) is a lightweight concrete material that was developed in Sweden approximately 85 years ago, but only recently, as early as 1990 in the Southeast, it has been used or produced in the United States. It is a lightweight building material that is easy to build with, has great thermal properties, and can be easily produced from locally available materials. AAC is commonly found as masonry block units or as larger planks that can be used as wall components or as roof or floor components. AAC has a high percentage of air, making up its volume and the materials that are used to make it can be recycled from the waste AAC material. Recycled AAC can be ground up finely and can be used as the aggregate in the new mixture. Also, the energy that is required to produce AAC is much lower than other masonry products. AAC is an industrially produced uniform and homogeneous material, which has been autoclaved. Consequently, its chemical and mineral composition has been stabilized to form a solid structure and is more stable than products formed from normally cured concrete. However, due to its porosity, AAC can be penetrated by liquids and gases, which, in some cases, may cause partial destruction of the matrix, either by dissolution or pressure caused by re-crystallization. AAC is mainly attacked by acids, solutions of acid salts, and acid forming gases. The degree of attack depends on the acid concentration, relative humidity and temperature. Moreover, the destruction of AAC can be caused by the formation of ice or salt crystals. In some countries, possible damage caused by freeze and thaw action is very important.

This research gives the detailed design of “two storied school building” by using AAC block masonry and conventional brick masonry, with the help of manual calculations, **STAAD-Pro V8i** design and **ETAB** design software. In this work we specially concentrate on design comparison between structural designs by AAC block masonry and conventional brick masonry.

B. Scope and Objective

This work includes the design and estimate of “two storied school building” by using AAC block masonry and conventional brick masonry, with the help of manual calculations, **STAAD-Pro V8i** design and **ETAB** design software. For smaller building, associated with conventional brick masonry works, AAC block masonry construction becomes too cumbersome, irrespective of the economics involved. For high rise building and very large spans, the depth required for an R.C.C. beam becomes impractical. The loading intensity is high in case of conventional brick is assumed, so that the dead load of structure is increased, factored bending moment will be increase.

This comparative point of view AAC block masonry is preferred as it is in vogue, during construction of a large span beam and high rise building.

II. CURRENT STATUS

Although several research studies have been conducted on the economics of autoclave aerated concrete vice-versa conventional brick, there is little research work on the same. An exhaustive literature review revealed that a minimum amount of research work had been done in India.

Eric Ray Domingo [1]

This report includes an explanation of the 2005 Masonry Standards Joint Committee (MSJC) Code for the design of AAC members subjected to axial compressive loads, bending, combined axial and bending, and shear. An example, building design using AAC structural components is provided. This report concludes that AAC has important advantages as a structural building material that deserves further consideration for use in the United States.

Gosson Al-Khaled, [2]:-

The topic presented in this thesis is a structural/design computer program developed for the Hebel AAC (Autoclaved Aerated Concrete) block building system to help engineers and architects working in this field. Computer programs are widely used in construction companies for many tasks, including structural analysis and design. The presented program is expected to save time, reduce human error and thus contribute to higher productivity and facilitate the exploration of alternate design solutions. The program is developed in Visual Basic, using the Hebel analysis design code, emphasizing a user-friendly graphic interface. Input and output are described, including the graphic interface, as well as the program's algorithm and underlying structural theory. Examples are included to demonstrate the program's use and capabilities.

Vikas P. Jadhao, Prakash S. Pajgade [3]

The construction of reinforced concrete buildings with unreinforced infill is common practice in India. Infill panels have traditionally been made of heavy rigid materials, such as clay bricks or concrete blocks. However, more lightweight and flexible infill options Such as AAC (aerated light weight concrete) blocks are now available in India to be used as masonry infill (MI) material in reinforced concrete (RC) framed buildings. The behavior of in-filled reinforced concrete (R/C) frames has been studied experimentally and analytically by a number of researchers. It has been recognized that infill materials give significant effect to the performance of the resulting in-filled frame structures. Most of the researches carried out in this area are focused on parameters such as the distribution of MI, variation of geometry, the strength of infill materials and the relative stiffness of infill to frame elements. The study of the effect of types of infill materials used (lightweight versus conventional brick masonry) on the behavior of in-filled R/C frames is however still limited. A previous experimental study has concluded that the R/C frame in-filled with AAC blocks exhibited better performance under lateral loads than that in-filled with conventional clay bricks. In the present paper an investigation has been made to study the behavior of RC frames with both AAC block and conventional clay brick infill when subjected to seismic loads.

III. METHODOLOGY

To begin with, an R.C.C. frame structure considering with conventional brick masonry was manually designed by using the limit state method based on IS: 456-2000. Based on the steps & formulas involved, a design program was prepared in MS EXCEL. The veracity of the program was checked by first designing the manually designed beam, column, slab, etc. by using the program & comparing the results. An identical procedure was followed for AAC block masonry loading.

In this work also compare the all calculation by using AAC block masonry and conventional brick masonry, with the help of manual calculations, **STAAD-Pro V8i** design software.

Programs were also prepared for estimating & costing. Rates are based on the latest CSR in Maharashtra.

IV. RESULT AND DISCUSSION

Fig.1 & Fig.2 shows the steel consumption of overall project in MT & percentage (%) by using AAC block is less than the steel consumption of overall project by using conventional brick masonry.

Fig.3 shows the steel consumption of plinth beam in MT by using AAC block is less than the steel consumption of plinth beam by using conventional brick masonry.

Fig.4 shows the steel consumption of slab beam in MT by using AAC block is less than the steel consumption of slab beam by using conventional brick masonry.

Fig.5 shows the steel consumption of column in MT by using AAC block is less than the steel consumption of column by using conventional brick masonry.

Fig.6 shows the steel consumption of footing in MT by using AAC block is less than the steel consumption of footing by using conventional brick masonry.

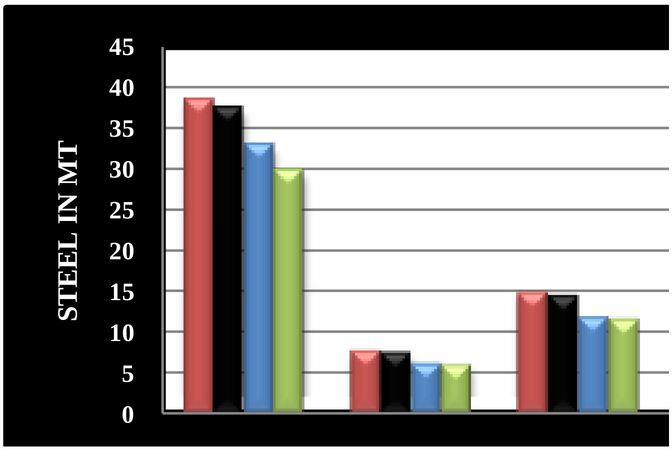

Fig.1. Overall steel consumption in MT

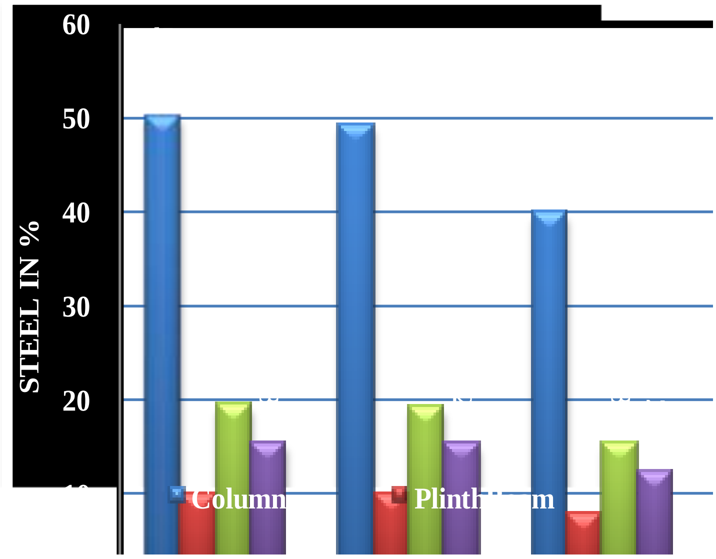

Fig.2. Overall steel consumption in percentage (%)

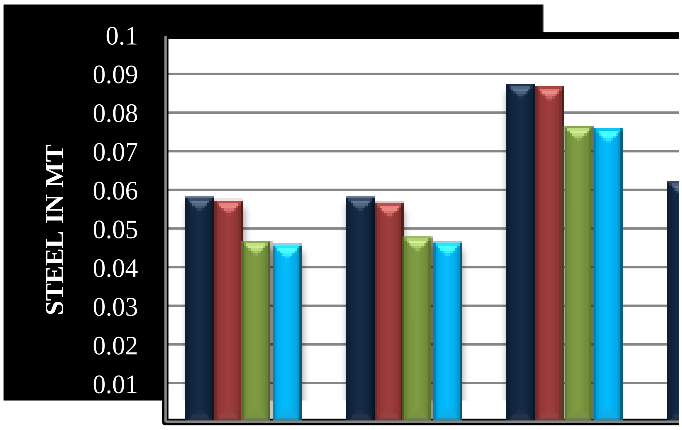

Fig.3.Steel Consumption of Ground Plinth Beam in MT

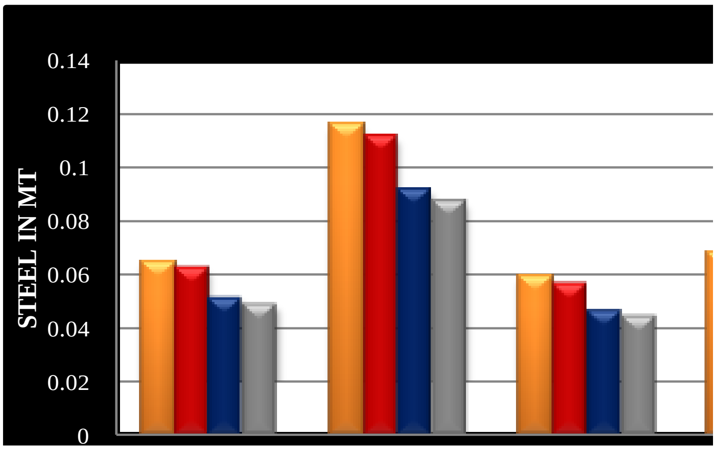

Fig.4. Steel consumption of slab beam in MT

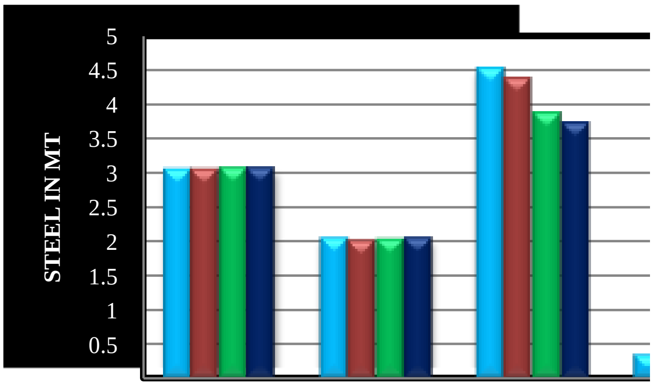

Fig.5. Steel consumption of column in MT

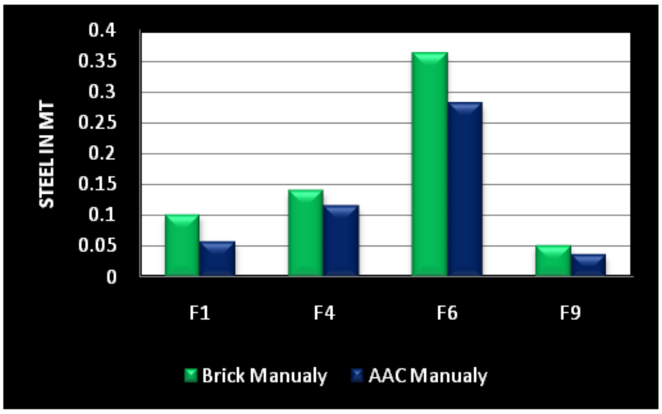

Fig.6. Steel consumption of footing in MT

Autoclave aerated concrete (AAC) block has been found to be economical as a construction material replaced by conventional brick. After designing the structure we are found that if we used AAC block in place of conventional brick we are saving almost around 10-15 % of steel in overall project. In general structure, the portion of partition wall is filled with conventional brick masonry, the average density of conventional brick masonry is 19 kN/m^3. Due to measure loading of infill wall indirectly increases the loading on beam and increases indirectly bending moment on beams also. As compare with conventional brick masonry the density of AAC block is much less i.e. 4.0-7.0 kn/m^3, result in saving steel.

The thickness of conventional brick is 230 mm, whereas autoclave aerated concrete (AAC) block having thickness 200 mm, result in increased the carpet area.

By using AAC block we can reduced the project duration, in case of construction with AAC brick masonry the binding agent as mortar is instead of binding solution, result in decreases the duration of construction.

AAC block weights almost around 80% less as compared to the conventional red brick ultimately resulting into great reduction of dead weight. Further, the reduced dead weight results into reduction of the use of cement and steel which helps great in cost savings.

V.CONCLUSION

[1] After designing the structure we found that we can save 11% of steel in overall project.
[2] Carpet area increased about 4% in same built up area
[3] We can save maximum amount of steel in beams rather than footing , column, slab , lintel, chajja i.e. 18 %
[4] if we used AAC block in place of conventional brick we are saving almost around 10-15 % in cost.
[5] Autoclave Aerated Concrete has been shown to provide better insulation to sound transmitted by air than other solid building materials, e.g. dense concrete, clay bricks, etc., under comparable conditions.
[6] AAC is non-combustible, and due to its low thermal conductivity and slow rate of heat transfer, AAC has high fire resistance capabilities.

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