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Analysis and Design of multi-storey building with different bricks employing STAAD.Pro Application in conjunction with behavior and influence of structure: A Review Paper

Vikram Singh Rathore, Dr. M. K. Gupta

M.E. Student (Structural Engineering), Dept. of Civil Engineering, BIT, Bhilai(C.G.), India
Prof., Head of Department, Dept. of Civil Engineering, BIT, Bhilai(C.G.), India

ABSTRACT: An edifice or commonly known as building, is an assembly of a roof and walls appearing in various sizes, shapes and functions, exhibiting several sociable needs – essentially as a shelter from weather, surveillance, solitude and comfortable livelihood. With the colossal growth in metropolitan establishment, the need for construction of multi-storey buildings has pivoted into a large demand in society. In this project, our aim is to analyze different types of bricks – such as Red Brick, CLC Brick, Fly Ash Brick and AAC Bricks, comparing their properties, elements collectively with their demeanor and significance on the structure and design a multi-storey building based on the conclusions and results obtained. Employing STAAD-Pro depiction and scrutiny of a multi-storey building is implemented in this paper. Along with this an evaluation of a multi-storey building is accomplished acknowledging the economical and conditional aspects.

KEYWORDS: STAAD-Pro, Cellular lightweight blocks (CLC blocks), AAC Brick, Fly-Ash brick, Red Brick, Structure analysis.

I.INTRODUCTION

A multi-storey building from the perspective of a structural engineer is described as a solitary structure by the ethic of its height, is afflicted in such a manner by the forces of wind or earthquake, to a degree that they impersonate its skeletal design[1]. Most customary block facade construction comprises of a load-bearing walls of either wooden or steel studs, or solid stone work units with brick units as finished walls. One can say that the bricks are functioning as a little more than 4" of paint. In a basic brick framework, the brick fills in as both a structural system and exterior finishing face. Utilizing bricks in both the building's exterior and internal structure takes advantage not only of its masonry strength, but also, in the building's engaging appearance and other inborn esteems[2]. Bricks, are primitive elements in the construction of the edifice, which encompass clay-bearing soil, sand, lime or concrete materials, although they can differ in innumerable classes, sizes, compositions and properties. However, the three most prominent properties that a brick should suffice are – strength, absorption and weather resistance. If these factors are satisfied, bricks make quite a durable material for masonry construction.

The bricks employed in this project is of cellular light weight concrete blocks (CLC blocks). Cellular lightweight concrete blocks are then catalogued in 3 grades such as Grade A, Grade B, Grade C. The comparison between the cellular light weight concrete blocks and the conventional red bricks is based on the analysis of a residential building. The density of cellular light weight concrete blocks is comparatively lower than the conventional burnt clay bricks and even they are absorptive, nontoxic, reusable, regenerative and can be recycled. Hence in high rise residential buildings, cellular lightweight concrete blocks are used as a reinstatement to the conventional burnt clay bricks. Considering how lightweight these blocks are, there is a decrease on dead load which acts on the structure, making it lighter to a large extent. The structure being tenuous, there will be a cutback in the reinforcement, reduction in the size of the member, decrement in the concrete and also by using these blocks the use of coarse sand for plastering purpose becomes counterproductive[3]. All these factors combined together will produce a competent and cost-effective

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structure. Before we commence contrasting between the bricks used in this project let us figure out a few properties, types and unique attributes which are available in them and which make them individual in their own specific manner, with the goal that we can get a clear picture of the purpose of composing this paper.

A.Types of Bricks:

It has been established that even in obscure ancient establishments bricks were the basic substance used for construction. This might be credited to various favorable circumstances it offers over other accessible materials of development like stones and cement such as – availability, construction mechanism, shape and size, treatment and cost. Four types of bricks have been utilized for the purpose of comparison in this project.
We will now observe a point by point portrayal of the different kinds of bricks and make an examination of them in light of different aspects:

I. Red Clay Bricks:

Red clay bricks are generally made by consolidating a blend of locally accessible mud and sand with the end goal that the ratio of sand is least 30% and maximum 50%. After the blend is set into molds they are kept in the sun for around 3 weeks for drying or else are prepared in the kiln at 1800°F for seven days. It has a size of 225mm X 75mm X 100/150mm with a variety size of 5 mm (+/-)[4]. According to IS codes it has a compressive quality of 3.5 N/mm^2 and dry thickness of 1800kg/m3.It can retain 17-20% of water of its aggregate volume.A single cum of red clay bricks costs roughly around Rs. 2440. These bricks have low thermal insulation when contrasted with AAC and CLC blocks and has resistance to fire for around 2 hours[5].

These are effectively accessible in local stretchand are incredible for development of low rise structures, nonetheless one sq. ft. of cover area with clay brick walling will devour 25.5 kg of top soil (approx), which actually harms the environment and since it has high heat conductivity (0.81 Kw-M/C). Hence, there are no noteworthy cost savings. These bricks require thick mortar surface as there are varieties in the measurements. Cylindrical sewer vents or sewage loads require small size of blocks with the goal that the curvature can be framed consequently. Red clay bricks are valuable, they likewise prove to be useful for both load bearing and non-load bearing structure.

II. AAC Bricks:

AAC mostly known as Autoclave Aerated Concrete or Autoclaved Cellular Concrete is a agile, precast, foam solid building material fabricated during mid-1920s that concurrently provides framework, fire-mold intransigence and insulation. Blocks, wall-panels, floor and roof boards, cladding or façade panels and lintels are all produce of AAC bricks. The substance was perfected by Dr. Johan Axel Eriksson in the Royal Institute of Technology and went into manufacturing in the Sweden in 1929. The raw materials in order to attain an AAC brick are quartz-sand, fly-ash, air-entraining agents while lime, and cement and water are used as a constraint agent. The size of the bricks is around 400-600mm X 200mm X 150–300mm with a variation of 1.5 mm (+/-). As per IS codes, it maintains a compressive strength of 3-4 N/mm^2 and dry density of up to 550-650 kg/m^3 which encompasses one third of the weight of clay brick which makes it easily portable[6].

It absorbs 10-12% of water of its total volume and hence reflects a low thermal conductivity of 0.24 Kw-M/C and an 8" inch wall of AAC can withstand a fire for up to 4 hours. For such bricks there is no top-soil consumption, so there is low carbon-dioxide emission. Chemical mortars are utilized for adjoining the brick which in-turn reduces the consumption of cement and also evades the process of curing. These bricks possess good dimensional accuracy so there is less requirement of thickness, in internal and external plaster. They commit to government taxes in the form of central, excise and VAT.A single cum of these bricks cost Rs. 4200 and being factory produce, they have high-end consistency and quality, which leads to compensating concrete and steel quantities[7].However, factory setup for the manufacturing of bricks is highly expensive hence, sometimes there are issues with its availability. AAC is appropriate for urban regions with tall

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structures and those with high temperature varieties and are advisable for non-bearing and or RCC design in partition wall.

III. CLC Bricks:

CLC is customary concrete, where in natural gravel is supplanted via air installed in an organic, hardened/stable and bio-degradable foam which causes no substance reaction however exclusively fills in as an "enclosing" material for the air implanted in the solid. CLC functions like conventional concrete, specifically concerning curing, solidifying and most imperatively ageing. CLC boundlessly expands its quality by hydration (framing of precious stones in bond) insofar as uncovered to humidity in atmosphere. The raw materials involved in the process of manufacturing of CLC bricks are cement, lime, specifically ground sand and foam. The procedure is based on generating air bubbles in the form of foam and then blending this foam with cement or in some cases fly-ash slurry. Since CLC slurries have higher bond substance, no autoclave curing is required – rather, the completed item is cured like typical concrete or Steamed Cured with low strain to accomplish early quality[8].

According to IS codes, these have a compressive strength of 2-2.5 kg/cm^2 and its dimensions are 400-600 x 200 x 100/150/200 mm with a variation size of 5 mm (+/-). They possess low thermal conductivity of 0.32 Kw-M/C, which helps is saving 30% electricity costs. It emits very low carbon-di-oxide while manufacturing hence, it is not harmful for environment. One cum of CLC bricks cost around Rs. 4000. The factory setup is low as compared to AAC, and if steam curing is utilized in production, manufacturing period is reduced. It has water absorption capability of 12-15% of volume of block. They possess a dry density of up to 800 kg/m^{3}according to IS standards and fire resistant for around 4 hours[9]. Joining of bricks is done by using chemical mortar as a result of which the material consumption of cement is reduced which furthermore abstains from curing process. Having good dimensional veracity, the solidity of plaster is also reduced. These bricks are majorly used for light-weight concrete panels, void fillings and are also used in structures located in the seismic zones in a bulk quantity.

IV. Fly-Ash:

Pulverized fuel-ash frequently known as fly-ash are mineral debris which is acquired after smoldering of coal/lignite in the boilers. It is a very valuable by-product of pounded coal as fuel in thermal power-plants. These are trifling and uniformly shaped bricks which not only make it easier for it to be transmitted but also acquire less mortar for the purpose of brick work and finishing. Being a by-product of thermal stations these are less energy embracive and are environment-friendly[10]. It also recoveries farming area which is utilized for assembling clay blocks. Preferably dry ash from 1st and 2nd fields of ESP's are poised to mark up the requirements for a Grade 2 IS: 3812 fly ash brick[11].

There are two most common compositions of fly-ash bricks – one consisting of 60-65% of fly-ash, 20-25% of sand/stone dust, 8-12% of hydrated lime and 5% of Gypsum. The other one containing 50-60% of fly-ash, 32-40% of sand/stone dust and 8-10% of cement. These are processed into a semi dry uniform mix in the vibro press. The bricks are allowed to air-dry for around 2 days and then water cured for 14-21 days. According to IS 3495 codes they have average water absorption of more than 20% and dry shrinkage not exceeding 0.15%. They possess a minimum compressive strength of 10-12 N/mm^2. They are cost efficient to clay bricks with 30% reduction in cost i.e. Rs. 1800 for 1000 bricks[12]. These are mostly considered as an alternative for clay bricks and are highly in demand for construction of paving roads and embankment, mine fills and for building various high and low rise structures.

B. Software Utilized:

Modeling is a technique that was utilized amidst the most recent 40 years by architects, planners and specialists. Many programming softwares had been accessible and were utilized by engineers for the purpose of analysis and design. STAAD Pro. program is one of these programming softwares and was utilized as a part of this probe for the design and analysis of the building model. The program is an application for structure and foundation plan and study developed

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initially by international research engineers in Yorba Linda, CA. It was initially, utilized for scholarly purposes for civil and structural engineers by Iowa State University. At that point, Bentley framework ratified the program and further amplified it so that it could be utilized as a part of designing and analysis of various developments work, for instance structural foundations, bridges, dams, tall buildings, and it can be considered as the expert's decision for steel, solid, timber, aluminum and cold-framed steel design of low and high structures, culverts, petrochemical plants, tunnels, piles and considerably more[13].STAAD Pro program is the most famous designing programming software utilized as a result of its simple interface, offering finite component, nature flexible at solving any issue, and gathering distinctive codes.

II.LITERATURE REVIEW

Keeping in mind the end goal to contextualize the current work, related works from literature are examined and gives an extensive survey of the work done by different researchers in the stretch of cellular light weight concrete blocks, ACC blocks and fly ash bricks at the substitution of regular burntclay bricks:

Dr. B G Naresh Kumar in this test contemplates the expediency of utilizing aerated concrete blocks as a contrasting option to the regular brick work units. The preparatory inspections concentrated on the assessing physical, quality and versatile properties of light weight concrete bricks i.e. autoclavedaerated cement bricks (AAC). These incorporate starting rate of absorption, thickness test, water assimilation test and so on. The compressive strength, modulus of elasticity and the flexural strength of the units were retrieved[14].

Prakash T Min 2013 investigated amid an examination that aerated concrete bricks have fine intermittent pores though solid concrete bricks had greater pores, which brought about low initial rate of absorption. The compressive strength, stress-strain attributes and the flexural quality of the units were acquired, in which in spite of the fact that the aerated concrete blocks had less compressive strength however since they had more modulus of elasticity they were viewed as considerably more positive for structural purpose[15].

K.Krishna Bhavani Siramin 2012, one of his works, made an endeavor to contrast CLC bricks and Clay bricks and propose a substitution material to red bricks in development industry. Burnt clay brick is the pre-overwhelming development material in the nation. The CO2 emanations in the block fabricate process have been recognized as a huge factor to global warming and furthermore concentrate on environment elucidation for greener environment since red bricks requires high energy to burn in furnace to be produced. This investigation has additionally demonstrated that the utilization of fly ash remains in foamed concrete, can enhance the properties of CLC blocks[16].

Ali J. Hamadsaid that his paper consists consideration regarding group of aerated lightweight concrete into foamed concrete and autoclaved concrete. The writing survey aerated lightweight concrete on material, production, properties and its applications. The aerated lightweight properties procures the porosity, penetrability, compressive strength and splitting strength. It groups numerous beneficial qualities such as, low thickness with higher quality compared with customary concrete, upgraded in thermal and sound insulation, lessened dead load which could result in diminish of auxiliary components and decrease the transferred load to the foundations and bearing capacity. Aeratedconcrete is considered economic in materials and utilizations of by-products such as fly ash.

NageshMustapure(2014)made an endeavor to examine cellular lightweight bricks, and experiments were done to check the properties of CLC bricks of Grade B, for example, compressive strength, water absorption, thermal conductivity of CLC for 800 kg/m3, 900 kg/m3, 1000 kg/m3, 1100 kg/m3. The incredible insulating property of foam concrete is because of the immense number of closed cavities framing the multi-cell structure. And the investigation demonstrates that CLC bricks might be utilized for development, which is invaluable as far as general development properties are considered and in addition are environment friendly[17].

A.K. Marunmale concentrate on the decrease of the development cost, time and work by utilizing Cellular lightweight brick divider in a Rat-trap bond for building masonry over the regular brick work framework. Development industry boom can be seen in all developing nations and with the expansion in material expenses in the development industry, there is a requirement to discover more cost sparing options to keep up the cost of building houses at reasonable costs. There is an urgencyto build up an elective arrangement of building segment which would give more advantages and are

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multifunctional with ideal utilization of labor andmaterial. In this way this method is a creative procedure for building masonry units impressively[18].

A.S. Mahajer(2014)examines the creation of lightweight refractory insulation boards based on perlite. For sparing energy in industrial furnaces, different types of insulations are utilized as blocks, bricks and fibers. Lightweight refractory insulation boards based on perlite (~30 wt. %) were effectively prepared by expelling system after sintering at 900-1100 degree centigrade. Attributes such as density, sintering shrinkage percent, perpetual linear change and cold crushing strength are estimated.

Sagar W. Dhengare(2015) presumed that the cellular lightweight concrete has an alluring quality to be a stand-in construction material for the industrialized building framework. It was made utilizing natural aggregate of volcanic origin, for example, pumice, scoria and so on. Lightweight concrete can be characterized as a sort of solid which incorporates an extending operator in that it builds the volume of the blend while giving extra qualities like inability and diminished dead weight. This investigation has demonstrated that the utilization of fly as in foamed concrete, can extraordinarily enhance its properties and its use gives a planned solution for building development industry alongside environmental conservancy[19].

Sohani N. Jani demonstrates the examination between the cellular lightweight concrete blocks, autoclaved aerated concrete and burnt clay bricks with their physical properties, density, thermal conduction and so forth and the principle concentrationlies on the scrutiny of microstructure and properties of autoclaved aerated concrete (AAC) block with its assembling procedure. There are two kinds of AAC creation strategy which are chemical and mechanical process. In the chemical procedure, some metallic compounds would be added to react and create gigantic measure of air bubbles in concrete structure while in mechanical process sweeping foaming agent is ordinarily utilized. AAC has magnificent properties of acoustic insulation, resistance to fire and allergy free while it has a tendency to endure edge damage or breakage in the event that it is subjected to abrasion or impact[20].

A K Soumini(2015**)** in this examination demonstrates that burnt clay bricks are ordinarily utilized for the building development works. The central pollution control board is cantered ensuing reduction in environmental pollution and global warming along withreduction in labor for the building development. They also decrease in the dead load in the building eventually prompt to lessen the cost of project. Cellular lightweight concrete block in contrast to burnt clay blocks and different materials helps to limit the environmental issues and lessen time and labor required in the regular procedure which is the need of the development business[21].

HjhKamsiah Mohd.Ismail (2014) has centered the low density and thermal conductivity of light weight concrete and its points of interest, impediments and application were examined completely.

Satyendra Kumar Meena (2014) examined that the cellular lightweight concrete has high flow ability, low self-weight, negligible consumption of aggregate, controlled low strength and amazing thermal insulation properties and has brilliant protection from water and frost.

P.S. Bhandari (2014)researched the conduct of cellular lightweight concrete in relation to density and compressive strength. The compressive strength for cellular lightweight concrete is low for lowerdensity blend. The compressive strength additionally diminishes with the augmentation of voids. Compressive quality of 53 grade cement is somewhat higher than 43 grade cement, however as strength expands its density additionally increments. Cellular lightweight cement is adequate for encircled structure and also reasonable for seismic tremor zones[22].

Ashish S. Moon(2015) presumed in his work that the foam concrete can be utilized for maintainable development as a building material since it is a sort of aerated lightweight concrete. Foam concrete does not contain any coarse aggregate. It require nocompaction, yet it will stream promptly from an outlet to fill confined and irregularcavities. Furthermore, lightweight foamed concrete is used in low strength limit with respect to building and civil development purposes because of its exceptional highlights such as low thermal conductivity, low self-weight and self-compacting features consequently its high workability[23].

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Chandrashekar and et al (2015) describes that building design and layout needs to take after the nature particularly for sunlight and directions. Geotechnical engineering cannot be ignored while constructing tall structures. The geotechnical engineer should be approached to perform soil sampling, scrutiny, ground water depth, and primarily for evaluation of soil-bearing capacity. The prospective building ought to be in a stretch where all forms of conveniences are available. For the designing purpose, IS456 and IS875 were utilized for figuring out the calculations of all forces and loads. The usage of light weight concrete and ingredients will diminish the dead load of structure, which at that point permits the structural designer to curtail the size of columns footings and other load bearing elements. The manifestation of fire is erratic and ambiguous, hence it is crucial to employ fire resistant materials and assets which suffice to the elevated requirements of performance in addition to dependability. For a structure more than 5 story, it is preferable to arrange the connecting beams amidst the flats. Limit state design acts as a best standpoint for constructing the buildings[24].

Rahul Chaudhary[2018], performed an analysis of light weight concrete bricks over red clay bricks. According to his study light weight blocks reduce mortar consumption, and offer an absolute perfect combination of durable, sustainable and efficient masonry unit. He also observed that the blocks are one third the weight of bricks and one fifth the weight of concrete, which reduces the dead load of the structure leading to less investment in steel and concrete. Blocks give superior thermal & acoustic insulation because of low air infiltration. Moreover, lesser joints and better compacted (thin) joining mortar add to the thermal & acoustic insulation. This leads to well insulated interiors, keeping out warm air in summers and cold in winters. Blocks reduce energy cost by up to 30%. Construction happens at a faster pace due to its large size and light weight[25].

III.CONCLUSION

With the escalation in world population, now is an ideal opportunity to maneuver for those kinds of structure which has ability to enfold the tremendous populace efficiently, and multi-storey buildings are the solitary units which can satisfy these prerequisites. Red bricks are currently being utilized as a part of structures with the end goal of partition of house and furthermore to make load bearing structures. Red bricksare set up by utilizing soil hence it diminishes the measure of soil which gives perilous impacts in environment. By utilizing AAC,CLC bricks we can limit these dangerous impacts. On the contrary, fly ash brick is a superior alternative for diminishing the destructive impacts of the industries, since it produces ash which is exceptionally unsafe for nature. AAC, CLC and fly ash bricks are better designing alternatives for buildings, as we can curtail the concrete and steel additionally. Subsequently, we can spare speculation by utilizing basic update in the procedure of shaping structures.

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AUTHOR'S BIOGRAPHY

Dr. M. K. Gupta was born in 26 April, 1969. He graduated in B. Tech from National Institute of Science Raipur in 1990, after that he pursued his Masters in Engineering from Shri Govindram Seksaria Institute of Technology and Science in 1992. He was completed is P.H.D. from Visvesvaraya National Institute of Technology.He is currently Chairman, Board of Studies, Civil Engineering, Chhattisgarh Swami Vivekananda Technical University. Dr. M. K. Gupta is a Technical Member of CED7 Committee of Bureau of Indian Standards and has contributed significantly towards the same.He has delivered expert lectures on Limit State Design of Steel Structures at DCE Delhi, VNIT Nagpur, SGSITS Indore, SVNIT Surat and GP Nagpur.He has also served as Honorary Secretary of IE(I), Bhilai Local Centre.

Vikram Singh Rathore was born in the year 1994 in Bilaspur, Chhattisgarh State,India. He completed his Bachelor of Engineering with honors from Chouksey Engineering College Bilaspur, after his graduation he is now pursuing M.Tech from Bhilai Institute of Technology, Durg, Chhattisgarh, India.He participated in many national and international conferences and seminar. He was an active participant in the BITCON, held in BIT, Durg in the year 2017 and 2018. He has also published an article in the International Research Journal of Engineering Sciences related to footings.