Effective Cost Comparison of a G+4 Residential Building Using Moderations in Structural Components Design

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Abstract: - In this research paper a G + 4 residential building (already constructed) was chosen for a case – study purpose, in which they have used the traditional bricks of cherry red colored. In order to make the structure more economical only change made was instead of traditional bricks, hollow cement blocks or A.A.C. blocks or C4x blocks were considered as partition walls in the proposed (imaginary) structure , as this proposed structure is not actually executed therefore it is termed as proposed or imaginary structure which is considered just for the comparison purpose. The density of traditional bricks is 18 KN / m^3 & that of A.A.C. blocks is 5 KN /m^3. The difference in their densities is about 28 %. Because of very low density of AAC blocks the load / m got reduced by 28 % i.e. The dead load due to partitions (AAC blocks) got reduced by up to 28 %. As the dead load was reduced the dimensions of all the structural members (slabs, beams, columns & footings) got reduced along with the reduction in steel percentage i.e. (diameter & no. of bars) in all the structural members. As a result the proposed G + 4 structures became more economical & this comparison is showed in this research paper. The comparison consist of two parameters i.e. concrete volume & the steel quantity required for both already constructed structure & proposed structure . Just by using a smart, sustainable, durable material i.e. AAC blocks, how the structure can be made more cost – effective. A more no. of floors can be raised in future with the application of AAC blocks.

Keywords: AAC blocks, bricks, comparison, cost – effective, dimensions, economical, sustainable, structure, steel.

I. INTRODUCTION

The traditional bricks are the main building materials that are used extensively in the construction & building industry. The density of traditional bricks is 18 KN / m^3.The traditional bricks are the main building materials that are used extensively in construction & building industries in India. Due to rapid urbanization & expanding interest for development materials, block furnace have quickly developed which have caused a progression of ecological & medical issues. At a worldwide level, ecological contamination from block making activities adds to the wonders of global temperature boost (global warming) & environmental change. The different kinds of blocks can be used as an option in contrast to red blocks, to diminish natural contamination & global warming. AAC blocks might be one of the answers for block substitution. AAC blocks brand name as Aerocon blocks.

Autoclaved aerated concrete blocks are recently one of the newly adopted building materials. The AAC blocks are energy efficient, durable, and less dense & light - weight. It has been observed that this material is an eco – friendly building material that is being manufactured from industrial waste & is composed of non – toxic ingredients. The paper also presents a comparative cost - analysis of AAC blocks with red clay bricks & its suitability & potential use in the construction in building industry. A brief comparison is showed in this research paper that just by using a smart, sustainable, durable material i.e. AAC blocks , how the structure can be made more cost – effective. It is accepted that totally a new thing is not being done in this research but an innovative one. As the dead load due to partitions was reduced by upto 28 % leading to reduction in structural members dimensions & steel reinforcements, the structure has become more economical / cost – effective. A more no. of storeys or floors can be raised in future with the application of AAC blocks. As due to shortage of land for constructions of residential buildings, horizontal growth is not permitted by

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the authorities particularly in metro cities like Mumbai & pune, so the residents are forced to adopt the vertical growth & this vertical growth will be supported by AAC blocks. So the use of AAC blocks is need of the hour & the need of the future & this research paper represents the importance of AAC blocks, by showing the comparison between the two structures (one with the use of traditional bricks & the other with the use of AAC blocks.) .The structural design (of both already constructed & proposed structure) was made by following of IS code provisions & no IS code by law has been broken in structural design of structural members i.e. Safety has not been compromised along with the focus on economy. The calculations are represented in excel sheet (tabular form)

.For the purpose of comparison few parameters are placed common such as the height of column (f2f height) , span of beams , length & width of slabs between the already constructed structure & the proposed structure. The proposed / imaginary structures structural plan / drawing are considered as typical i.e. same for all the floors. All the calculations of an already constructed structure were done according to the structural design which was provided in structural drawings. The proposed structures structural design was made, based on the analysis of structure which was done in STAAD. Pro software. Then by following the structural design all the calculations were done.

1.1 AIMS & OBJECTIVES.

1) To discover or search more cost – effective or economical structural design for societal benefits, so that the lower middle class or particularly the lower class / poor people can get the benefits of this research.

2) To show how the use of AAC blocks can reduce the dead load of structure, structural members dimensions, steel reinforcements in structural members & how structure can be made more economical or cost – effective. i.e. how use of a new building material can make the structure more economical.

3) To show that by using AAC blocks how we can make the building economical structurally.

1.2 METHODS OF MAKING BUILDING OR STRUCTURE ECONOMICAL.

1) By using conventional method.

2) By using smart materials.

3) By low – cost housing method.

4) By sustainable (eco – friendly) use.

1) By using conventional methods (traditional red clay bricks): The raw material required for producing red clay bricks is just the locally available clay. The size of red clay bricks is generally 0.225 x 0.075 x 0.10 m. The compressive strength (as per IS code) of red clay bricks is 3.5 N / mm^2 , the dry density (as per IS codes) of red clay bricks is 1800 kg / m^3 .The cost – benefit of red clay bricks is that as it is locally available in the market it is beneficial for low rise structures. The fire resistance of red clay bricks is around 2 hours. The sound insulation of red clay bricks is normal. The cost of construction of red clay bricks is 1 cum cost – 2,440 Rs. In the joining process of red clay bricks the traditional mortar needs to be used & the brickwork should be cured at least for 7 days before plastering. Red clay bricks are available locally in all cities & villages. A red clay brick has a low thermal insulation as compared to A.A.C. blocks. A red clay brick does not contribute to tax, which is good. A red clay brick absorbs 17 – 20 % of their total volume. Red clay bricks are useful in both load bearing & non – load bearing structures.

2) By using smart materials (A.A.C. Blocks): The raw materials required for producing A.A.C. blocks are cement, fly ash, water & air entraining agents. The standard size of AAC blocks is generally 0.4 / 0.6 x 0.2 x 0.15 / 0.3 m. The compressive strength (as per IS code) of A.A.C. blocks is 3 – 4 N/ mm^2. The dry density (as per IS code) of A.A.C. blocks is 550 to 650 kg / m^3 i.e. one - third of weight of red clay bricks which makes it easy to lift & transport. The cost – benefit of AAC blocks is that, for high rise buildings there will be a reduction of dead load which leads to saving in concrete & steel quantities. The fire resistance of AAC blocks is upto 4 hours. The AAC blocks have a better sound absorption / insulation as compared to red clay bricks. The AAC blocks are energy efficient having a low thermal conductivity, helps in saving electricity cost upto 30 % for heating & cooling of the house. The cost of construction of AAC blocks for 1 cum is 4,200 Rs. In joining process of AAC blocks chemical mortars can be used for joining the blocks. This reduces the material consumption for cement & avoids curing process. AAC blocks are good thermal insulators if cooling is a major component, it will save cost for an entire lifetime. The water absorption capacity of AAC blocks is very less i.e. AAC blocks absorbs only 12 to 15 % of total volume of AAC blocks. AAC blocks are suitable for non – load bearing or R.C.C. structure, as partition walls.

3) Low cost housing method: In order to reduce the cost of R.C.C. slab an alternative technique is adopted i.e. the idea of parabolic arch is taken into consideration. This also helps in increasing the speed of construction, because the arch shape is very effective at carrying loads & spanning distance. A variety of forms are possible for construction of roofs. That means engineers have more flexibility available to them when thinking about the overall aesthetics of the structure. In low -cost housing method

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locally available materials are used & care is taken of ample light & good ventilation. In low cost – housing method green materials can be used for eg : mud mortar , lime mortar, Ferro cement. If Ferro cement is used as green material then there is no need of tensile reinforcement as birds mesh is used along with Ferro cement. In low – cost housing method the shape of building is made more aesthetically good, for e.g.: vault shape, dome shape. The drawback of low – cost housing method is that maximum three – floors can be raised i.e. G + 2. In low – cost housing method load is distributed uniformly on vaults or arches, the compression in vaults or arches resist the entire load acting on it as in case of 2 - hinged & 3 - hinged arches. Low – cost housing method can not only be used in rural areas for poor people but can also be implemented in urban areas. So, low – cost housing method is a good sustainable method for making a building or a structure more cost – effective or economical.

4) By sustainable or eco – friendly use: AAC blocks are not only smart materials but also a sustainable (eco – friendly) material i.e. they do not harm the ecology or environment. In AAC blocks there is no top soil consumption & it emits very low carbon dioxide as compared to red clay bricks while manufacturing. Since AAC blocks are an industrial product manufactured with machines, the quality of the end products is very good, uniform, and consistent. Autoclaved aerated concrete (AAC) has many advantages as compared to other cement concrete materials. The basic advantage is that it is cost-efficient and Eco-friendly with having a low environmental impact. The manufacturing process of AAC blocks is non-polluting. The by-product from the manufacturing industry is only steam. All the ingredients used to manufacture the AAC blocks are non-toxic and safe. The AAC blocks are fire resistant and non-combustible.

II. LITERATURE REVIEW

Vivian W. Y. Tam. [1]

In this research paper the author in abstract part have very good mentioned about the adequate shelter for all people is a challenge for developing countries. Author stated that India is currently facing a shortage of about 17.6 million houses. Also stated the fact that owning a house particularly for low income & middle income families has becoming a very difficult reality. Hence it has become a necessity to adopt cost effective, eco – friendly & innovative technologies for the construction of houses & buildings to enable common people to construct houses at affordable cost. Author stated his research paper compares construction cost for traditional & low cost housing technologies. The author has compared construction method of foundation, walling, roofing & lintel. Authors highlighted that strength, durability, stability, safety & mental satisfaction are factors that assumes top priority during cost reduction. In the introductory part author mentioned that in developing countries like India, only 20 % of population are high income earners who are able to afford normal housing units. Also stated that low income groups in developing countries are generally unable to access the housing units. Also added that "cost – effective housing" is a concept which has more to do with budgeting & seeks to reduce construction through better management, appropriate use of local materials, skills & technology but without compromising with performance & structures life.

Hasan J. Mohammed. [2]

In this research paper the author has done a good, deep & systematic structural & cost – analysis of 5 different structural models with 2 different materials (namely steel & concrete). The names of 5 different structural models are 1) concrete with beams building model. 2) Concrete with flat slabs. 3) Concrete walls pre – cast. 4) Steel frame with plastic analysis. 5) Steel frame with elastic analysis. Cost, analysis & comparison have been done of all these structural models with each other. It was found that concrete with pre – cast concrete reduced the total cost of building model upto 24 %, 29% & 67% for concrete flat slab model, steel frame & concrete with beams building model. The deflection in concrete with pre - cast concrete wall model is minimum. The authors have done the comparison using commercial mathematical software SAP 2000 for analysis of multi – storeyed buildings & design of steel structure buildings. The author in this research paper has compared 5 structural models with 10 different & important parameters including cost. The different parameters are displacement, deflection, bending moments, buckling moments, shearing force, axial force, slabs reinforcement, beams reinforcement, column reinforcement & finally the cost. The results showed that slab cost in concrete flat slab building model greater than other building models. Beam cost in concrete with beam building model greater than 2 steel beams building model. Column cost of concrete flat slab building model greater than other building models. The least column cost was in 2 steel building models & was same in 2 steel building models. The building cost of concrete pre – cast wall building model less than other building models. Also the cost of concrete beam building model greater than cost of concrete flat slab & concrete wall pre – cast. Also the cost of concrete wall pre – cast building model less than cost of 2 steel building models.

Maria Fernanda Laguardo Mallo & Omar Espinoza. [3]

In this research paper the authors have mentioned about a new innovative material called as C.L.T. (cross laminated timber & have compared it with concrete. In the abstract part the author says that C.L.T. (cross laminated timber) is an innovative structural system which is made by use of large format, multi-storeyed panels of solid wood board &

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are glued together. This cross laminated timber are used as panels that are monolithic, stable & experience minor shrinkage which allows them to be used as walls, roofs & floors. Developed in Switzerland in 1990 as a method to reduce the waste in sawmill. This system has been used successfully in Europe for the past 20 years & recently used in Australia & north-America. Authors say that their research has shown that C.L.T. can be more-competitive & an alternative to concrete structures for buildings over 6 storey high. In the conclusion part the author says that it is hypothesized that if C.L.T. is compared with other types of pre- fabricated material e.g. ; pre – cast concrete that could allow similar saving in construction time, the C.L.T. would come out to be more cost-effective due to lower material cost (between $5 & $20 square feet.). For C.F.T. panels between ($14 & $ 40) square feet for a tilt up concrete solution & the lower weight of 29 Ib/sq.ft. for wood & 150 Ib / sq.ft. For concrete which directly results to smaller & shallower foundations.

Dinesh Choudhary, K. Swathi , K. Padmanabham. [4]

In this research paper the authors have compared the results of a 20 m span R.C. (reinforcing beam) with a P.T. (Post – tensioning) beam of same span. The model was analysed in E- tabs software & was designed manually. Also the quantities of concrete & steel required were compared for slab, beam, column, footing for cost- effectiveness purpose. The plot area of commercial building was 20 m x 20 m & was six-storied (G +5) multi- storied building. Geometrical plan of floor system was shown in fig. in which 5 beams along Y- axis with 20 m span & 2 beams along x-axis with 20 m span was showed. i.e. total 7 beams of 20 m span on each floor. The authors says that in R.C.C. case the depth of beam increases with increase in span due to deflection limitations. In pre-stressed structures the depth of beam can be reduced, for longer spans the pre-stressed beams are cheaper than R.C.C. beams. From the graph plotted between cost (in lakhs) vs. type of beam (R.C. & P.T.) it was observed that the construction cost of frame structure of R.C. beam model (model – 1) is more 1,20,000,00 as compared to P.T. beam (model -2) 1,09, 000,00 with a difference of about 10 %.

Anil K.Kar, Urmil V. Dave & Ritesh S. Varu. [5]

In this research paper the authors have compared the use of PSWC – bars with other rebars. PSWC – bars benefits / advantages has been showed by performing experiments on various columns. The author in abstract part states that the use of PSWC – bars which are characterised by their plane surface & a gentle wave type configuration, can enhance the life span of concrete structures several times through the minimization of rate of corrosion in rebars. Also, the test at different universities have showed the highly improved performance of beams that are reinforced with PSWC – bars. In this research paper the authors have showed the same is true / correct in case of columns too, by performing the experiments on 11 different types of rebars.

Authors highlighted that PSWC – bars do not require any special treatment for their effectiveness in enhancing the life span of reinforced concrete construction, increasing load carrying capacities & transforming brittle concrete structures into ductile ones. Also, numerous tests had earlier demonstrated that the use of PSWC – bars as rebars in concrete flexural elements led to many positive benefits. Test on concrete columns showed that the use of PSWC – bars can enhance the load carrying capacity of column under axial load. This adds to the confidence in use of PSWC – bars which in absence of surface ribs can greatly lower the rate of corrosion in rebars of steel. The results conclusively showed that there is no adverse effect on the structural performa nce of columns when PSWC – bars are used as rebars. Authors concluded that PSWC- bars enhances the life span of concrete structures in a significant way & raises the performance of reinforced concrete columns under load. The ratio of test load to analytically determined capacity of columns was highest at 1.37 when PSWC – bars are used. The engagement of effective bond between rebars & surrounding concrete is highest when PSWC – bars are used as rebars.

III. METHODOLOGY

The methodology of this project is that simply just by replacing the traditional bricks by A.A.C. blocks how the structure can be made more cost – effective or economical without compromising with safety of the structure & also with following of IS code provisions has been done. When A.A.C. Blocks were used as partition walls the dead load of the structure was reduced, due to which the dimensions of all the structural members were reduced & also the quantities of steel reinforcements were also reduced / decreased. An innovative work has been done in this project.

3.1 Visual observations.

1. A G + 4 residential building was taken for project purpose. The building site is located in Yunous colony near kat – kat gate road, Aurangabad. The plot area of building is 1900 sq. ft & the built – up area is 1700 sq. ft. Due to less depth of hard strata present no foundation (soling, murum filling, and flooring) was provided. But P.C.C. was done for footing purpose. There are total 14 footings of structure of 2 types i.e. F1 & F2. F1 (big size) footings are of 11 columns & F2 (small size) footings are of 3 small columns. All the footings are of simple box type. As it was hard strata (Murum), the S.B.C. of soil tested was 350 KN /m$^{2.}$ Above the footings pedestals are provided of 2 types i.e. P1 & P2. P1 pedestals above 11 footings of F1 & P2 pedestals above 3 footings of F2.
2. Similar to footings there are 11 columns of big similar

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sizes (C1) on P1 pedestals & 3 columns of small similar sizes (C2) on P2 pedestals. The floor – to – floor height from G.F. to F.F. is 14' 4'' (4.3434 m)

& from F.F. to S.F., S.F. To T.F. & T.F. to F.F. is 13' 3'' (4.0412 m) & from F.F. to F.F. is 10' (3 m).

3. The length of building / structure is 51' 6'' & the width is 37' 7''. The plinth height is 2'. The traditional bricks are used in structure as internal walls & external walls. Density of traditional bricks is 18 KN / m^3. Dog- legged staircase & a lift is provided in building. Concreting was done from R.M.C. through transit mixers.

4. G.F. (ground floor) plan consist of an office & guest bedroom with W.C. attached on half side &

remaining half consist of a meeting room & parking space. The F.F. (first floor) plan consists of a fountain in living room / hall, kitchen cum dining, W.C., bath, a store room & a gym. The S.F. (second floor) plan consist of a big slab cut – out, a master bedroom & a wardrobe beside it. The T.F. (third floor) plan consist of 3 master bedrooms i.e. W.C. & bath attached to bedrooms & a wardrobe in each master bedroom. The F.F. (fourth floor) plan consist of kitchen cum barbeque, master bedroom with wardrobe on half side & a small swimming pool open to atmosphere on half side surrounded by a retaining wall. The F.F. (fifth floor) is a terrace part & will be used for keeping the roof tanks on it & enjoying a top view of surrounding area from it.

5. The dog –legged staircase, lobby, lift & duct have a constant or same position from G.F. (ground floor) to F.F. (fourth floor). A round staircase is provided from 1^{st} (first floor) to 2^{nd} (second floor) & from

2^{nd} (second floor) to 3^{rd} (third floor) for use of building occupants only. A very high grade of concrete & steel was used & no compromise was done with safety without caring about economy or cost (over concrete & over steel quantity) was used in an already constructed structure, i.e. very much more than that required. The structural part construction was done very fast (4 months) & remaining construction part took much more time (10 months).

IV. RESULTS & DISCUSSIONS.

TABLE NO. 1 (GRAND TOTAL COMPARISON OF CONCRETE VOLUME WITH % REDUCTION & DIFFERENCE)

CONCRETE VOLUME COMPARISON					
		A.C.S.	P.S.		
SR. NO.	STRUCTURAL MEMBER	VOLUME (IN M^3)	VOLUME (IN M^3)	% Reduction	DIFFERENCE (IN M^3)
1)	FOOTINGS	58.84125	36.105	38.6399847	22.73625
2)	PEDESTALS	2.6225	0	100	2.6225
3)	G.F. BEAMS.	14.76551	14.0949878	4.541138098	0.6705222
4)	G.F. SLAB	23.626936	19.36575875	18.03525116	4.26117725
5)	F.F. BEAMS.	15.2332	14.0949878	7.471917916	1.1382122
6)	F.F. SLAB.	26.60031359	21.79558311	18.0626836	4.80473048
7)	S.F. BEAMS.	13.816238	12.7587008	7.654306476	1.0575372
8)	S.F. SLAB.	19.90125255	16.21303171	18.53260658	3.68822084
9)	T.F. BEAMS.	15.42091339	14.3300228	7.074098417	1.09089059
10)	T.F. SLAB.	24.18877684	19.78596924	18.20186126	4.4028076
11)	F.F (FOURTH FLOOR) BEAMS.	16.96052897	14.0949878	16.89535259	2.86554117
12)	F.F. SLAB.	26.60031359	20.04754424	24.63418083	6.55276935
13)	F.F. (FIFTH FLOOR) BEAMS.	12.1274424	12.31436	-1.541277986	-0.1869176
14)	F.F. SLAB.	18.793037	15.65631802	16.69085726	3.13671898
15)	TOTAL VOLUME OF ALL FLOOR COLUMNS.	55.1006091	46.4175506	15.75855266	8.6830585
16)	GRAND TOTAL.	344.5988214	277.0748027	19.59496509	67.52401876

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The table above shows the concrete volume comparison of all the structural members of the two structures along with the difference in between them with the percentage reduction in them. The percentage reduction of concrete volume can be observed in the proposed structure which clearly indicates that the concrete volume required in case of proposed structure is much less as compared to the already constructed structure i.e. the proposed structure has proved out to be much more economical than the already constructed structure, which shows that the project objective has been achieved.

TABLE NO. 2 (GRAND TOTAL COMPARISON OF STEEL QUANTITY WITH % REDUCTION & DIFFERENCE)

STEEL QUANTITY COMPARISON.					
SR. NO.	STRUCTURAL MEMBER	STEEL (IN QUINTALS)	STEEL (IN QUINTALS)	% Reduction	DIFFERENCE (IN QUINTALS)
		A.C.S.	P.S.		
1)	FOOTINGS	30.05661	10.6967	64.41148885	19.35991
2)	PEDESTALS (INCLUDING SHEAR REINFORCEMENTS)	6.4199	0	100	6.4199
3)	G.F. BEAMS & SLAB QUANTITY (INCLUDING SHEAR REINFORCEMENTS)	37.060651	24.617893	33.57404056	12.442758
4)	F.F BEAMS & SLAB	26.754951	24.617893	7.987523505	2.137058
	QUANTITY (INCLUDING SHEAR REINFORCEMENTS)				
5)	S.F. BEAMS & SLAB QUANTITY (INCLUDING SHEAR REINFORCEMENTS)	28.900488	21.364684	26.07500607	7.535804
6)	T.F. BEAMS & SLAB QUANTITY (INCLUDING SHEAR REINFORCEMENTS)	33.424847	24.617893	26.3485245	8.806954
7)	F.F.(4TH FLOOR) BEAMS & SLAB QUANTITY (INCLUDING SHEAR REINFORCEMENTS)	35.28511	24.617893	30.23149708	10.667217
8)	F.F. (5TH FLOOR) BEAMS & SLAB QUANTITY (INCLUDING SHEAR REINFORCEMENTS)	21.963275	20.86204	5.01398357	1.101235
9)	TOTAL QTY. OF ALL FLOOR COLUMNS STEEL (INCLUDING SHEAR REINFORCEMENTS)	88.695619	69.882098	21.21133063	18.813521
10)	GRAND TOTAL.	308.561451	221.277094	28.28751184	87.284357

The table above shows the steel quantity comparison between the already constructed structure & the proposed structure. The steel quantity required by beams, their shear reinforcement & the slab above them has been presented collectively for easy comparison purpose. The difference of steel quantity between the two structures can be easily observed along with reduction in steel percentage in every structural member for the proposed structure. This table also indicates the proposed structure is much more economical than the already constructed structure when compared in terms of steel quantity. The grand total of steel quantity required by both structures & the difference in between them along with the percentage reduction can be observed from the table above.

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V. CONCLUSION

From the table no. 1 which represents the grand total comparison of concrete volume following points can be concluded:

1) For the footing structural member the concrete volume required by A.C.S. is 58.84125 m^3 & by proposed structure is 36.105 m^3 having a difference of about 22.73625 m^3 & percentage reduction of about 38.6399847

2) For the pedestal structural member the concrete volume required by A.C.S. Is 2.6225 m3 & in proposed structure no pedestal was provided.

3) For the G.F. beams the concrete volume required by A.C.S. is 14.76551 m^3 & by proposed structure is 14.0949878 m^3 having a difference of about 0.6705222 m^3 & a percentage reduction of about 4.541138098

4) For the G.F. slab the concrete volume required by A.C.S. is 23.626936 m^3 & by proposed structure is 19.36575875 m3 having a difference of about 4.26117725 m3 & a percentage reduction of about 18.03525116

5) For the F.F. (first floor) beams the concrete volume required by A.C.S. is 15.2332 m3 & by proposed structure is 14.0949878 m^3 having a difference of about 1.1382122 m^3 & a percentage reduction of about 7.471917916

6)) For the F.F. (first floor) slab the concrete volume required by A.C.S. is 26.60031359 m^3 & by proposed structure is 21.79558311 m^3 having a difference of about 4.80473048 m^3 & a percentage reduction of about 18.0626836

7) For the S.F. beams the concrete volume required by A.C.S. is 13.816238 m^3 & by proposed structure is 12.7587008 m^3 having a difference of about 1.0575372 m^3 & a percentage reduction of about 7.654306476

8) For the S.F. slab the concrete volume required by A.C.S. is 19.90125255 m^3 & by proposed structure is 16.21303171 m^3 having a difference of about 3.68822084 m^3 & a percentage reduction of about 18.53260658

9) For the T.F. beams the concrete volume required by A.C.S. is 15.42091339 m^3 & by proposed structure is 14.3300228 m^3 having a difference of about 1.09089059 m^3 & a percentage reduction of about 7.074098417

10) For the T.F. slab the concrete volume required by A.C.S. is 24.18877684 m^3 & by proposed structure is 19.78596924 m^3 having a difference of about 4.4028076 m^3 & a percentage reduction of about 18.20186126

11) For the F.F.(fourth floor) beams the concrete volume required by A.C.S. is 16.96052897 m^3 & by proposed structure is 14.0949878 m^3 having a difference of about 2.86554117 m^3 & a percentage reduction of about 16.89535259

12) For the F.F. (fourth floor) slab the concrete volume required by A.C.S. is 26.60031359 m^3 & by proposed structure is 20.04754424 m^3 having a difference of about 6.55276935 m^3 & a percentage reduction of about 24.63418083

13) For the F.F. (Fifth floor) beams the concrete volume required by A.C.S. is 12.1274424 m^3 & by proposed structure is 12.31436 m^3 having a difference of about -0.1869176 m^3 & a percentage reduction of about -1.541277986

14) For the F.F. (fifth floor) slab the concrete volume required by A.C.S. is 18.793037 m^3 & by proposed structure is 15.65631802 m^3 having a difference of about 3.13671898 m^3 & a percentage reduction of about 16.69085726

15) Total volume of all floor columns required by A.C.S. is 55.1006091 m^3 & by proposed structure is 46.4175506 m^3 having a difference of about 8.6830585 m^3 & a percentage reduction of about 15.75855266

16) The grand total of concrete volume required by A.C.S. is 344.5988214 m^3 & by proposed structure is 277.0748027 m^3 & having a difference of about 67.52401876 m^3 & a percentage reduction of about 19.59496509 From the table no. 2 which represents the grand total comparison of steel quantity following points can be concluded:

1) For the footing structural member the steel quantity required by A.C.S. is 30.05661 Quintal & by proposed structure is 10.6967 Quintal having a difference of about 19.3033 Quintal & percentage reduction of

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64.34433333

2) For the pedestal structural member the steel quantity required by A.C.S. is 6.4199 Q. & in proposed structure no pedestal was provided.

3) For the G.F. beams (including shear reinforcement) & G.F. slab, the steel quantity required by A.C.S. is 37.060651 Q. & by proposed structure is 24.617893 Q. Having a difference of about 12.442758 Q & A percentage reduction of 33.57404056

4) For the F. F.(first floor) beams (including shear reinforcement) & F.F. (first floor) slab, the steel quantity required by A.C.S. is 26.754951 Q. & by proposed structure is 24.617893 Q. having a difference of about 2.137058 Q. & a percentage reduction of 7.987523505 .

5) For the S.F. beams (including shear reinforcement) & S.F. slab, the steel quantity req uired by A.C.S. is 28.900488 Q. & by proposed structure is 21.364684 Q. having a difference of about 7.535804 Q & a percentage reduction of 26.07500607

6) For the T.F. beams (including shear reinforcement) & T.F. slab, the steel quantity required by A.C.S. is 33.424847 Q. & by proposed structure is 24.617893 Q. having a difference of about 8.806954 Q. & a percentage reduction of 26.3485245

7) For the F.F. (Fourth floor) beams (including shear reinforcement) & F.F. (fourth floor) slab, the steel quantity required by A.C.S. is 35.28511 Q. & by proposed structure 24.617893 Q. having a differenc e of about 10.667217 Q. & a percentage reduction of 30.23149708

8) For the F.F. (fifth floor) beams (including shear reinforcement) & F.F. (fifth floor) slab, the steel quantity required by A.C.S. is 21.963275 Q. & by proposed structure is 20.86204 Q. having a difference of about 1.101235 Q. & a percentage reduction of 5.01398357

9) The total steel quantity of all floor columns steel (including shear reinforcements) required by A.C.S. is 88.695619 Q. & by P.S. is 69.882098 Q. having a difference of about 18.813521 Q. & a percentage reduction of 21.21133063.

10) The grand total of steel quantity required by A.C.S. is 308.561451 Q. & by proposed structure is 221.277094 Q. having a difference of about 87.227747 Q. & a percentage reduction of 28.27435275

VI. FUTURE SCOPE

In this research paper traditional bricks were compared & replaced by AAC blocks, the analysis & design was done by using the Staad. Pro software. How the structure can be made more economical just by use of AAC blocks as partition walls instead of traditional bricks was showed. The structure was made more cost – effective by the application of AAC blocks. Further research work related with this topic can be done on:

1) How the structure can be made more cost – effective or economical by using the CLC (cellular light weight concrete) blocks i.e. analysis & design of structure by using the CLC blocks & a comparison of traditional bricks with CLC blocks to make the structure more cost – effective or economical.

2) To make the structure more cost effective comparison can be done of AAC (autoclaved aerated concrete) blocks & CLC (Cellular light weight concrete) blocks i.e. analysis of structure by using AAC blocks & by using CLC blocks to determine which material proofs to be more cost – effective or economical structurally.

3) Comparison can be done in between the traditional bricks & interlocking blocks, simply just by using the interlocking blocks in place of traditional bricks how economy can be achieved structurally by doing the analysis & design of structure using softwares.

4) To determine which material proves to be more economical structurally between the traditional bricks of small sizes & traditional bricks of large size (19 x 9 x 9 cm).

5) In low – cost housing method economy can be achieved without any doubt, to determine which material can be used in low - cost housing method other than mud mortar , lime mortar, ferro cement, so that instead of G +2 more no. of floors can be raised safely.

6) Finding out that which new material having less density can be used instead of traditional bricks to make the structure more economical.

7) To determine that casting of mortar (not individually but as one unit using formwork) as partition wall can prove to be economical structurally or not.

8) To determine that casting of mortar (not individually but as one unit using formwork) with the addition of broken pieces of bricks as partition walls can proof to be structurally economical or not.

9) A comparison can be done in between the AAC blocks & the interlocking blocks to determine which material is more cost – effective structurally.

10) In framed structures load is not transferred on walls, so using of very low grade concrete (M10) as a partition wall can be structurally economical or not ?

11) The compressive strength of interlocking blocks & sandcrete blocks is almost the same & interlocking blocks construction proved to be faster than sandcrete blocks with better workability & labour cost of both

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interlocking blocks & sandcrete blocks is almost the same. Interlocking blocks are more affordable than sandcrete blocks in favour of low –cost construction i.e. interlocking blocks are more economical than sandcrete blocks , research can be done on which material can make the structure more economical, as was done in this research using AAC blocks.

12) Application of interlocking blocks in low – cost housing method can make the structure more economical or not ? Whether use of interlocking blocks can allow more no. of floors to be raised in low - cost housing method.

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