TO STUDY COST EFFICIENCY OF BUILDINGS IN DIFFERENT GEOGRAPHICAL LOCATION OF INDIA BY UTILIZING WASTES IN CONCRETE

A

THESIS

Submitted in partial fulfillment of the requirements for the award of the degree

of

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With specialization in

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Under the supervision

of

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by

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

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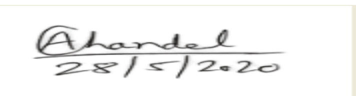
May-2020

STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"To Study Cost Efficiency of Buildings in Different Geographical Location of India by Utilizing Wastes in Concrete"** submitted for partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat,** is an authentic record of my work carried out under the supervision of **Mr. Chandra Pal Gautam**, **Assistant Professor**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.



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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"To Study Cost Efficiency of Buildings in Different Geographical Location of India by Utilizing Wastes in Concrete"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in "Structural Engineering" and submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Akshay Chandel , 182657** during a period from July, 2019 to May , 2020 under the supervision of **Mr. Chandra Pal Gautam**, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

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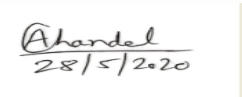

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ABSTRACT

Today, the need to protect the environment is a moral obligation for humans. Concrete is the most devoured material on the planet after the water and utilized most broadly in the construction due to its properties. According to the Ministry of Environment, Forests and Climate Change of INDIA (MoEFCC) in 2018-19 nearly 15,000 MT of garbage remain exposed every day, resulting in almost 55 Lakh MT of solid waste disposed in open areas each year, which leads to "severe" pollution level. Of the total collected waste, only 20 per cent (27,000 MT per day) is processed and the remaining 80 per cent (1, 08,000 MT per day) is dumped in landfill sites. Furthermore, recycling waste consumes energy and produces pollution. Besides, the gathering of waste in the suburbs and the removal of waste are perilous for nature. Utilizing waste material in Concrete is an appropriate technique for accomplishing two objectives: eliminating waste and adding positive properties in concrete. Since the green concrete industry is growing, it is important to assess concrete that contains waste from all perspectives to determine its capability. The goal of this study is to inspect the concrete properties when it is replaced with waste materials as components. In this study the crumb rubber replaced with san, bagasse is used as cement, and waste crushed tiles are used as coarse aggregate up to some amount as a replacement. With the addition of these wastes we can reduce carbon footprint, and save the natural resources. Different tests on concrete are performed to check the feasibility of these waste materials. With the help of right strategy the Green concrete can be used for making G+3 building in Autodesk Revit architecture and further design in different parts of India by Stadd. Pro software. After that the energy efficiency of the building is also checked and then Cost comparisons of buildings are done with Zero Energy Building through Estimator software. Further cost efficiency of the building is checked by Estimator software. And then stability is checked in different harsh environment conditions of India in Stadd.pro.

Keywords: Bagasse, Crumb rubber, Compressive strength, Mosaic, Harsh.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	**Description**
BFS	Blast furnace slag
CA	Coarse aggregate
CSH	Calcium silicate hydrate
C & D	Construction and Demolition
EA\C	Emulsified asphalt content
FA	Fine aggregates
GBA	Ground bagasse ash
GGBFS	Ground granulated blast furnace slag
HSC	Ground granulated blast furnace slag
HWA	Hospital waste ash
MSW	Municipal waste ash
NCA	Natural coarse aggregates
OPC	Ordinary Portland cement
PPC	Portland pozzolana cement
RCA	Recycled concrete aggregates
SCBA	Sugarcane bagasse ash
UCS	Unconfined compressive strength
CTM`	Compression testing machine
W/C	Water cement ratio
RCC	Reinforced cement concrete
PCC	Plain cement concrete

CHAPTER 1

INTRODUCTION

General

"Green concrete" is a revolutionary topic throughout the entire existence of concrete industry. This was first comes into play in late 90's in Denmark by Dr. WG. There are different numbers of alternatives for environment need with which the Green Buildings must execute:

- Reduction of Carbon dioxide up to 30 %.
- Up to 20 % of concrete residual products must be used as an agregate.
- Must use Residual or Demolished products.
- Previously land filled or disposed residual products must be used.
- CO_2 - neutral, waste-derived fuels must be replaced with fossil fuels in the production of cement by at least 10 %.

Concrete

The most broadly utilized material on earth after water is concrete. Due to its endurance, sustainability, and economy it becomes the worlds most extensively used construction material. Concrete mixes are of two types, i.e. nominal mix and design mix. The use of a nominal mix is for small construction works. Firstly proper mix proportion is known, and afterward the materials are blended in the ratio as selected. Methods which are mainly adopted for the mixing purpose are, Hand mixing or Machine Mixing. In view of the quantity and quality of concrete needed, the proper mixing method is going to be chosen. In the process of hand mixing, each ingredient is going too set on a level surface and then water is included which is blended with hand tools. In machine mixing, the addition of components in the desired quantity is done to produce the fresh concrete. When it is mixed properly it is shifted to the location for casting and then filled in formworks. Then the poured concrete is permitted to set in formworks for a particular time based on the type of structural member to attain enough strength. Then the evacuation of these formworks is done, and curing is done by different strategies to make up the loss of dampness due to evaporation. Reaction of hydration of cement with water is required for setting, strength gain. Hence, curing is commonly accomplished for at least 7 days when the formwork is expelled.

Waste

Waste is any substance that is disposed of after its essential use, or it is useless and damaged. The world produces 2.01 billion tons of metropolitan strong waste every year, with at least 33% is not managed in safe manner. . Furthermore, recycling of waste consumes enough energy and produces pollution due to carbon emission. Also, the collection of waste and its disposal is very hazardous for the environment. Utilizing waste material in Concrete is a proper technique for accomplishing two objectives: decreasing waste and computing positive properties in concrete. As the green industry is expanding day by day, it is important to figure out concrete that contains waste from all aspects to determine its capability. Sources of waste can be extensively characterized into four types:

Industrial Waste

These are the wastes originates from factories and industries. Most industries dump their losses in waterways and oceans which causes a great deal of water contamination. Example**:** plastic, glass, etc.

Commercial Waste

It consists of waste used mainly for the purposes of a trade, but excluding household, agricultural and industrial waste

Domestic Waste

The wastes are gathered during different household work like cooking, cleaning, etc. are known as domestic waste. Example: leaves, vegetable peels, etc.

Agricultural Waste

These wastes are generated in the agricultural field. Example: cattle waste, weed, husk, bagasse, etc. The most significant waste materials utilized in concrete as per following:

- Plastic
- Crumb rubber
- Hospital waste ash
- Ground bagasse ash (GBA)
- Fly ash

- Blast furnace slag (BF slag)
- Waste crushed tiles
- Rice husk ash RHA
- Electronic waste
- Hospital waste ash(HWA)
- Municipal solid waste ASH(MSW)
- ground granulated blast furnace slag (GGBFS)

In my work there are three types of waste considered. They are:

- Waste mosaic crushed tiles (as coarse particles)
- Crumb rubber (as fine aggregate)
- Ground bagasse ash (as binding material)

Why so much interest in these waste?

- As high amount of silica and alumina, the SCBA can be positively used as a pozzolanic material
- Ceramic mosaic waste have properties like strong, durability, hardest and resist the biological forces.
- The addition of rubber helps in reducing the workability and thaw damage, highly resistant to thermal changes, afford sufficient restrain against propagation of micro-cracks.
- About 0.1 million tons of metropolitan strong waste is created in India consistently for example 36.5 million tons every year
- By using the waste in concrete we can leave a lesser carbon footprint on the earth and thus promote the well being of the environment for future generations.

Application

- lightweight concrete
- cement saving up to 20% – 30%
- low workable concrete
- durable concrete

Advantages

- low construction cost
- low workability
- restrain micro-cracks
- restrain thermal change
- helps in waste management
- leads to sustainable construction
- natural resources can be saved
- reduces the landfill cost
- energy saving

Disadvantages

- Requires proper proportion and lab tests which may increase the cost of the project.
- Concrete which is partially replaced with waste may not have a longer life span.
- We have to compromise with strength.
- Additionally, we have to add superplasticizer which can increase the cost of the project.
- No proper guidelines and awareness amongst the peoples.

Need/Demand

- Waste management
- Reduce using natural resources
- Lightweight concrete
- Reduction in carbon footprint
- Low-cost construction
- Natural concern and the Green structure idea

CHAPTER 2
LITERATURE REVIEW

Introduction

Several types of waste materials i.e. ash of rice husk, recycle aggregate, fly ash, sewage sludge, waste glass sludge, marble powder, crumb rubber, electronic waste, hospital waste ash and many more were used in concrete mix design by researcher across the world. It was observed that benefits of these waste materials as replacements of material in concrete results in the mix which is eco friendly, less cost and leads to sustainable construction. Different guidelines were proposed by the researcher across the world for the use of waste material in different proportions. This examination is about crumb rubber, ceramic crushed tiles and bagasse. Crumb rubber is used as fine aggregate, waste crushed mosaic tiles as coarse aggregate and ground baggase as cement in the concrete mix. The following literature review dicusses about mix ratios, nature, design and the use of these waste in concrete mix. These waste materials were further optimized and outcomes were compared. This Literature reviews the waste materials effect on the of concrete mix design properties.

Review of Literature

Assadollahi et al. [1] did a study to find effects of mixing crumb ruber in the concrete mix. Crumb ruber is obtained from tyre and used as the sand replacements in the concrete. In this study effects of concrete on the addition of crumb rubber are examined such as axial strength and flexure strength of un-reinforced concrete. A control mix design was prepared in the experiment with target strength (compressive) of 34.5 MPa, another mix was designed by replacing the fine aggregate with crumb rubber thus, maintaining the constant weight. Crushed limestone and sand are used as the course and the fine agregate in the mix. Crumb rubber size is decided according to mesh size(increasing order) of 3.35 mm and 1.40 mm(6-14 Mesh); 2.00 mm and 0.841 mm(10-20 Mesh); 0.297 mm and 0.178 mm(50-80 Mesh).the author made 3 cylinder specimen for each composition of 0%, 2%, 4%, 6%, 8%, and 10% as substitution of fine aggregate by weight. Now, all spe-cimens are examined for compressive strength and authors found that when 10% crumb ruber added the 6 - 14 which is the largest mesh shows the continuous decrease in compressive strength because this mesh has particle size greater than sand due to separation of sand and crumb rubber. Also when crumb rubber is added at 2% the 10-20 Mesh shows that there is some strength increase this is because 10-20 Mesh size is less than 6-14 mesh and a cylinder containing 50-80 Mesh shows the maximum decrement in the compresive strength which is said to be the most inconsistent result as compared to all. Now flexure strength of square beams of size 508 mm x 152 mm is measured by pouring the mix in cylindrical mould and tempered manually by 50 blows per layer. When beams are tested on the compression machine it was concluded that beams made from 10-20 Mesh and 50-80 Mesh shows a decrement in the flexural strength on addition of 4% crumb rubber. So by this experiment, authors found out that the crumb rubber can potentially be replaced by 4% as sand in concrete which leads to clear the complications of decomposing this crumb rubber waste and leads to sustainable construction.

Bing et al. [2] investigated the rubber particles use obtained from tire as coarse agregate in concrete. In this experiment rubber is replaced with 0%, 25%, 50%, 75%, and 100% in concrete by volume. Four different mixes were prepared to study the effects of w/c and ratio of emulsified asphalt cement (EA/C) on rubberized concrete properties. Different tests on rubber concrete were carried out like dry unit weight, the compressive strength, and elastic strength and then comparison is done with controlled concrete. Materials used by the authors are OPC with strength of 57.5 MPa, stone gravel(20mm maximum) is used as coarse aggregate, natural sand (4.75 maximum) is used as fine aggregate, tire rubbers obtained from shredding of rubber in industry, polycarboxylic ether is used as a superplasticizer. In this experiment some rubber particles are replaced by coarse particles by 0%, 25%, 50%, 75%, and 100% (by volume). Two groups of the mixture were designed taking w/c ratio as 0.4 and another one as 0.60. The coarse aggregate for These two groups was substituted with 0%, 25%, 50%, 75%, and 100%, III and IV series of mixture was designed with substitution of 100% with 0.05, 0.10, and 0.15 as EA/cement ratios. Therefore16 specimen (concrete mixture) was casted in the lab with a paddle mixer. After that the mixture is mixed for 5 minutes and then allows it to settle for 3 min. For rubber concrete with the EA, particles of rubber are mixed with EA for one minute and after that the diluted superplasticizer was added in cement, fine and coarse aggregate. Then mixing is done for 7 min to achieve the homogenous mixture .all specimens are compacted on the vibrating table and curing is done. After 24 hr sample is removed from mould and place in a completely humid environment (95%) until testing. strength test is done at the temperature of 20°C show that when the ruber particle is added in the concrete mix as a coarse aggregate there are large reductions in compressive strength. Also when emulsified asphalt (EA/C) is added, there is an strength increment for EA/C ratio less than 0.10 and decrement in strength for EA/C more than the

0.10. This study also concludes that modulus of elasticity, flexural strength, unit weight and the slump value is decreased with the addition of rubber particles as coarse agregate due to lower stiffness and poor bond in between the rubber and the paste. But on addition of emulsified asphalt which increased bond in between the rubber and the paste results in increasing flexural strength, workability, greatly. So in last the authors concluded that emulsified asphalt must be added in concrete having rubber particles as coarse aggregate to get positive results.

Rattanachu et al. [3] researched to make the concrete with high strength (HSC) using ground bagsse ash (GBA) and rec.ycled concrete agregate (RCA). High fined GBA is used as a cement replacement (up to 50% as weight of binder). In this experiment OPC was used as the main binder, GBA as a substitute for cement, recycle coarse aggregate is formed from concrete columns which are rejected. High strength recycled concrete was made from recycled coarse aggregate, river sand, ground bagasse ash with cement as 10, 35, and 50% (w.r.t weight of binder)and Conventional high-strength concrete (CT) was made from Natural coarse aggregate (NCA)as crushed limestone and local river sand (fine aggregate).while comparing the porosity of NCA limestone and RCA, the authors found that the porosity of limestone(1.55%) is very low as compared to RCA(12.63%), which is because of voids between mortar and the paste of cement. This resulted in higher water absorption of RCA. based on ASTM C88 the soundness of aggregated was measured in terms of weight loss, authors found that the loss of weight of RCA(43.31%) is ten times larger then the limestone(4.02%).Authors also founds that sulphate resistance for RCA is more than NCA, but on addition of GBA sulphate resistance increased and expansion values of RCA also decreased. also on GBA replacement with 20%, 35%, and 50% of cement the expansions for RAC is less than Normal high-strength concrete (CT). furthermost, the GBA(with 35% and 50%, replacement of cement) decreased the surface damage of RAC .also compressive strength of CT (69.1MPA)is almost the same as of RCA(69.7MPA) with expansions of 0.053% and 0.073%, respectively. In last the authors concluded that Recycled aggregate had low durability which has a great affect on lower durability of the concrete. Also he founds that use of the recycled agregate as full replacement in place of limestone results in higher expansion value of concrete which can be further decreased by the addition of 50% of GBA. The findings also showed that when GBA is added in recycled concrete aggregate there is a decrease of sulphur attack risk. So by this study one can conclude that the use of GBA and recycled aggregate can leads to eco-friendly high strength concrete with very high sulfate resistances and very less water permeability.

Danish et al. [4] study on replacing some of the coarse aggregate with waste crushed tiles from 10% to 50% and the sand with powder of granite by 10% with the ceramic coarse tile. In this study authors want to find the potential percentage to replace waste crushed tile as coarse aggregate in concrete. Various tests like workability of concrete, Compression test for concrete, and Split tensile test has done. Materials utilized in this examination are OPC 53, local river sand (specific gravity of 2.59), Crushed aggregates collected from local plants having a size less than 20mm and the specific gravity of 2.9, water of pH between 6 to 9, and crushed tile (specific gravity 2.6 and water absorption as 0.19%) aggregate, granite powder (specific gravity of 2.4) are used. From the results obtained from the experiment, authors conclude that the workability of mixes is increased from 4% to 49% for different mixes (M1 to M9) with normal M25 grade (M0). Also the split tensil strength of mixes (M1 to M9) increased from 1% to 7% respectively when the comparison is done with normal concrete (M0) after twenty eight curing days. Also the concrete strength increased by 1% to 19% respectively as correlated with the conventional concrete (M0) after curing. The author also found that the strengths of mixes M3, M8 is highest by replacing coarse aggregate by 30%. To improve the workability authors suggested the use of granite while using crushed tiles as coarse material. Hence 30% is the potential value to replace coarse aggregate by mosaic tiles waste. Thus the tiles waste can be used in construction works as a coarse material that leads to sustainable construction.

Fattuhi N et al. [5] suggested that when crumb tire particles is replaced with sand in the concrete then we can see an improved performance them full replacement level. Also few replacement level of crumb tire particles as sand is proving better strength to concrete. Also with this replacement, crumb tyre imparting better shear capacity, resistance to fire and spalling resistance due to some environment hazards like rainwater, fire hazard and collective segregation in concrete.

Eldin and Senouci et al. [6] founds that, the TRAC batches show better achievement in placing, handling and the finishing. Also they come to know that when the size of the rubber aggregate is increased, then the workability decreased and reduced the value of slump. They also found that the rubber aggregate size and its shape affect the slump value. The slump values of mix which contains long, the angular ruber agregate are less than for mix which contains ruber agregate with round shape. Also, the Round ruber agregate has a very less surface to volume ratio, and hence mortar required is less. They proposed that the rubber aggregates with angular size will form an engaging structure that resists the concrete flow under the weight; hence the mix has less fluidity. It may be conceivable that the existence of this steel wire bulge from tyre chips of also helps to reduce the workability of the mix.

Biel et al. [7] studied the tyre rubber use in the concrete mix which is made with the cement of magnesium oxychloride, and the aggregates were replaced with 25% fine crumb Positive results of compression and the tensile strength are found out and the better bond between aggregates was found out when oxy chloride magnesium cement is used. The authors also found that the application of this concrete mix in structure is possible when the rubber is limited to 17% as aggregate volume.

Gregory et al. [8] carry out the analysis of concrete with waste tyre modified when riplaced with the waste tyre as tyre fiber and dispersed chips in the concrete mix. He found increase in the toughness, along with crack resistance of concrete. But there is strength reduction of the sample made with rubber. Also the stress concentration of the concrete having rubber fiber is less when contrasted with the concrete having rubber chip. Hence concrete modified with rubber fiber can sustain a larger load as correlation to rubber chip concrete before the breaking of concrete.

Humphrey et al. [9] studies the tyre chips properties which include density, its permeability, the high thermal insulation, and durability, with high bulk compressibility. Crumb rubber has been effectively utilized as another option for aggregate in both asphalt concrete and PCC. This material is used in various engineering structures like highway base courses, embankments, etc.

Morales et al. [10] study the composition of baggase. Researchers' found that baggase has few amount of silica, as a component. Out of these ingredients the silica component is a lot higher than others which helps in pozzolanic reactions. The Calcinations temperature of bagasse helps in obtaining higher pozzolanic reaction.

Srinivasan et al. [11] founded that blended SCBA has higher compressive, the tensile and the flexural strength as compared to concrete without the SCBA. Researchers studied that the cement replacement by SCBA up to 10%.Also when SCBA quantity is increased then there is decrement of concrete density which leads to the production of low weight concrete.

Prashant et al. [12] suggested that with percentage increment in bagasse the coefficient of sorptivity also gets increased. The poros nature of SCB.A and some presented waste in it leads to permeable concrete. They also found that on using bagasse in pure form then it will become a better replacement of cement.

Jagadesh et al. [13] make a comparison of the mechanical behaviour of the concrete when two types of raw and processed SBA are inter mixed with concrete. The processed SBA was achieved by 45 minutes ball mill grinding of the raw SBA and then burning at 400°C in a furnace for 4 hours. The results showed that the processing of the SBA caused an increase in specific gravity and the density and reduced the mean size mass particle size of the SBA. The results showed that the concrete specimens mixed with the processed SBA have a greater density than those mixed with raw SBA. It was indicated that the finer particles fill voids and well-distribute in the mixture and therefore provide a denser specimen, and a higher value of unconfined compressive strength (UCS) value. Besides, filling the pores is promoted even more when finer reactive silica presented in the processed SBA reacts with calcium hydroxide and generate calcium silicate hydrate (CSH). Smaller particle sizes have a larger surface area and therefore a more promoted the pozzolanic activities within the specimens are recorded. A similar trend was recorded for modulus of elasticity (MOE) and the modulus of rupture.

Bahurudeen et al. [14] investigates on the effect of various particle sizes on the pozzolanic activity of the SBA. They initially burnt the bagasse at particulate temperatures and then removed the coarse and unburnt carbon fibrous particles by sieving through a 300 μm mesh. The remained SBA was ground at various timeframes until 210, 180, 150, 125, 105, 75, 53, 45 μm fineness was achieved. Then, the strength activity index and unconfined compressive strength tests are performed to examine the effect of particle sizes on the pozzolanic activity of SBA. From the results it clear that only the pozzolanic activity of the SBA with 53 and 45 μm fineness is equal/greater than the required activity index at seven and twenty eight days curing periods and can be categorized as the supplementary pozzolanic materials to mix with OPC. To achieve the maximum pozzolanic activity, it was suggested to grind the raw SBA at the OPC fineness level (i.e., 300 m2/kg) after removing the coarse and carbonic fibrous particles through 300 μm sieve.

Chusilp et al. [15] inspected the effect of treated SBA on compressibility, permeability, and heat production of the concrete specimens. The OPC was replaced with three SBA contents of 10, 20, and 30%. This shows that all SBA treated specimens had a greater compressive strength and a lower permeability in comparison with benchmark specimens when cured at higher curing periods like 28 and 90 days. It was also highlighted that the specimens containing 20% SBA has the highest UCS value. Further analysis showed that increasing SBA contents of the specimens was effective to reduce their heat rise. It was concluded that the SBA is an effective pozzolanic by-product which will improve the mechanical characteristics of the concrete.

Daniyal et al. [16] in their investigation on replacing Waste Ceramic Tile Aggregates in Concrete with Natural Coarse Aggregates from 10% to 50%, the optimum value with a 0.5 w/c Ratio is approx. 30%. The strength of concrete made from these waste was found 5% and 32%high than normal concrete. The workability of concrete was high for WC ratio of 0.6 and considered appropriate whereas for WC ratio 0.4 it was found to be very low & hence inappropriate. The workability of concrete with WC Ratio 0.5 is also low but considered appropriate generally. Author concluded that Mass density of the concrete decreased with increment in W/c ratio & the weight of the structure.

Rajalakshmi et al. [17] Studies on change in strength if we replace Waste Ceramic Tiles with aggregates in concrete. As water absorption of ceramic aggregate is high, the workability of concrete made with ceramic aggregate reduces as the replacement of ceramic aggregate value is increased. Compressive strength achieved by ceramic tiles aggregate concrete was good. The ceramic waste aggregate concrete has shown good resistance to the chemical attack such as sulphate and chloride attack and concluded that one can use waste tiles as an elective materials for concrete aggregates.

Kumar et al. [18] studied that what are the effect when we use Waste Ceramic Tiles when 10% to 20% replacement for the Coarse and Fine Agregate in the Concrete It was observed that when tiles powder ratio is increased the strength and workability also get increased, and maximum strength was achieved for 20% of the tile powder. Also for every mix there is increment in strength but the maximum strength shows for the mix having crushed tiles as 10% and tiles powder as 20%. So the ideal value for aggregate to be replaced with crushed tiles was 10%. Also there is a minor increment in the concrete workability.

Singh et al. [19] study "the use of Ceramic Tiles Waste as replacement of Coarse Aggregate in Concrete" and the results indicated that except M 30 mix there was no effect on the concrete strength in M 20 and M 25 mixes if we replace 20% as 20 mm coarse aggregates with waste tile agregates but after that, strength started decreasing progressively with increaing proportion of tile %age in the concrete. For all concrete mixes compressive strength decreased with increment in the dosage of replacing the natural aggregates because of less specific gravity & high porosity of tile agregates as compared to natural agregates. For making 1m^3 of concrete by replacing 20% aggregates (20mm) with the waste tile aggregates then about approx. 16% amount can be saved.

Jain et al. [20] investigate the earthquake behavior for a house on a ground having slope. In this research, G+4 storey building is considered and then the analysis is done with different slope angles of 0, 15, 20, 30 and 40 and then the comparison is done on flat ground conditions. Also he considers many soil conditions for the analysis. Authors used stadd. pro software for this analysis. All the loads like dead load, live load, seismic load, are calculated manually and added in stadd. pro. Then materials properties like density, young's modulus, compressive strength of steel, etc and size of all structural member is inserted in the software. Also soil properties like density, modulus of elasticity, Poisson ratio is inserted and the soil is characterized as SC, DS, HC, RCk. M^1 M^2 M^3 M^4 M^5 showed the 5 storey with slope angles of 0, 15, 20, 30 and 40. The results of this study showed that for all models storey displacement is maximum for soft clay and lowest for Rock (SC>DS>HC>RC). Hence by this study authors concluded that by increasing the soil stiffness the storey displacement also increased. Also with a decrease in the height of footing columns, there is an increase in stiffness which leads to increased horizontal forces i.e. shear and bending moment. Hence by this study it can be concluded that while making the structures on sloping ground condition we must build it on a rocky soil.

Likhitharadhya et al. [21] investigates the displacement of storey, the Acceleration of Storey, Base shear and also the period of Mode for G+ 10 storeys building on a sloping ground and then compare it with level ground conditions. Authors used E-Tabs software for making G+10 buildings with sloping angles from 10 to 30 degrees. All the required values like material values, geometric properties, and gravity loads are inserted in software and analysis is done. From results it is concluded that storey displacement, joint displacement, storey acceleration is maximum for 11th storey and minimum for base storey. The author also observed that for 20-degree slope base shear is maximum. While comparing the base shear along the Horizontal and Vertical direction, x-direction has high base shear than Y. Also they investigated that asymmetrical buildings on plane ground resist more shear (40%) than asymmetric sloped buildings. Hence vertical irregularity is said to be more critical than plan irregularity for a structure. So if one has to make the building on a sloped ground, he has to make all floors the same i.e. one has to maintain the vertical irregularities.

Ganapati et al. [22] analyzed the Reinforced Concrete Frame structure having a Floating Column on sloping ground. In this study fourteen, 10 storey building was considered out of which 6 models having step back construction with the floating columns, 1 steps back building having no floating column, 6 model having step back-set back construction with the floating column and remaining 1 is having steps backs – sets backs structure having no floting column. Further the analysis for pushover is done for all models, using the E-TABS software. Each model consists of story height as 3m, beam size as 300 x 450 mm, column size as 600 x 850 mm, and slab thickness is 125 mm. The structure is located in fifth earthquake zone and stands on medium soil. M 20 concrete and Fe 500 are used for construction with the live load as 3kN/m2 and floor finish of 1kN/m2. From the result, the authors concluded that storey shear, drift, and displacement, increases with the floating column. Also building made from step back-set back there is a decrease of maximum displacement as compared to step back building. Hence by this study we can conclude that floating columns are considered to be critical especially at corners. Thus while making the building in the sloping region we must avoid floating columns.

Gawande et al. [23] conducts research work regarding the effect of saltwater on concrete and compare it with normal water. In this study the all the strength parameters are checked and further compare with M30 grade of concrete. In this study crushed granite stone as coarse aggregate(<20mm), sand used as a fine aggregate, Portland Pozzolana Cement, freshwater which is free from suspended impurities and water containing 35 g of salts in one litre of water is used. Concrete cubes, cylindrical mould and beams were casted with. After curing the specimens the different strengths for concrete after 28 days which is mix and cured with salt is more than concrete made with normal water. Hence the authors concluded that the rate of gaining strength is more for saltwater and there is no reduction in strength while using saltwater in concrete. Hence by this study one can use saltwater in concrete while mixing or curing where saltwater is the only problem.

Khan et al. [24] discussed the technique used in different parts of the world to make the building flood-resistant. Some techniques like amphibious housing, raising the elevation, wet floodproofing, etc. have been discussed in the paper. Firstly the building should be raised above the base flood elevation with the help of supports. These supports are so strong that they can bear all the forces exerted by floodwater. If any place is under a low probability of water then space below the living area can be utilized as parking purpose. Some other techniques like making the openings and walls of lower area to be watertight by using Enclosures, sealants, membranes and coatings, etc. These sealings are so strong that they can bear the uplift and lateral forces exerted by water at the time of the flood. The author also discussed the construction of the amphibious house which can flow in the water at the time of flood and then come back to their original position when flow recedes. These houses are of two types: - boat type and lift type. Boat type houses are free to move in both directions i.e. vertical and horizontal and the house is water sealed to stop penetration of water also house is tightened with an isolation system to stop dislocation from the original position whereas lift houses are free to move only in the vertical direction. With the help of guided columns these houses are restricted in the horizontal direction. The buoyant foundation is used in lift type house in which a block made of plastic bottles. By this study authors concluded that for protecting the house against floods one must use an amphibious foundation which also helps to reduce the waste and lead to sustainable construction.

Vikram et al. [25] studies the effect of wind in static and dynamic analysis of buildings using ETABS. Authors consider different aspect ratio and some variation in bending moment and axial force to find out the behavior of frames. Buildings are made by considering storey height as 3.5m, the thickness of slab as 0.15, beams of size 300 x 450mm, columns of size 300 x 450mm, number of stories as 10, 15, 20, 25, 30 with an aspect ratio of 0.25, 0.5, 1, 1.5, 2 respectively, wind speed of 50m/s, Grade of steel as Fe 415 and M25 as the grade of concrete. Also, four load cases are considered as:

Load cases 1.5(DL+WL) to 0.9DL+1.5WL are taken to examine the effect of wind while load case 1.5(DL+LL) is used to study dead and live loads. From the results authors found that for dynamic analysis when the aspect ratio is 0.25 there is an increase in axial forces are by 10% when compared with static analysis. Also while increasing the aspect ratio from 0.25 to 2 there is a decrease in axial force by 3%.In this study the bending moment due to gravity will remain the same in all load cases and aspect ratio. From this study we can conclude that if aspect ratio is less wind effects is important to gravity effects and effect goes on decreasing when the aspect ratio increases.

Arya et al. [26] study the effects of velocity of wind and the structure response on a slope of ground. In this study 60 cases of different wind zones with different heights and different wind zones are considered. Authors consider the height of buildings as 8, 12 and 16 story, sloping angle of 0, 5, 10 and 15, 5 wind zones according to IS- 875 (part-3):1987, the density of Rcc as 25 kN/m3, the density of masonry 18.5 kN/m3, the foundation is 1.5m below the sloping ground, storey height of 3m, size of columns and beams as 350*350mm.from the results author found that with an increase in slope, the height of the building, and wind velocity the axial force, shear force in columns and beam increases. But with an increase in sloping ground the max. Bending moment in the beam doesn't have any effect. Talking about maximum storey drift there is an increase in drift with an increase in ground slope only before the 3^{rd} storey while above 3^{rd} floor it starts decreasing. Thus in last authors conclude that effects of wind are mostly ignored for buildings having height low to medium. Also for slender frames they found to be more effective than dead and the live loads.

Russell et al. [27] study the effect of the relative humidity on the prediction rate of carbonation of concrete. This study consists of different 8 mixes of concrete with four w/c ratios, as 0.50, 0.57, 0.63, 0.70 and two content of cement s of 375 kg/m3 and 315 kg/m3, 10mm coarse aggregate and the fine aggregate of medium size. The specimens were cured at 40 degree Celsius. The author measured humidity on the air permeability, carbonation of concrete. Results obtained from the experiment showed that RH values between 55 and 65%, the rates of carbonation (RoC) found to have the greatest change but from RH values between 65 and 75%, the rates of carbonation (RoC) found to decrease. Hence by this study we can conclude that with an increase in relative humidity the carbonation rate of concrete increases.

Subramaniaprasad et al. [28] studies the tensile strength behavior of reinforced soil with plastic fibres using the split tensile strength test so that it can be used in soil masonry blocks. The author used OPC 43 as a stabilizer, two types of fibres are used – The first one is polyethylene terephthalate (PET) bottles and the second one is carry bags (pick up bags). Chopping of plastic bottles is done up to minimal width of 2mm and 2cm of length. 0.1 and 0.2%(by weight of soil) of fibres were taken. Compaction pressure is regulated by CTM (capacity of 1000kn) and the least count of 100N and moulding pressure interval of 1.25-MPa (from 1.25-MPa to 7.5-MPa).before mixing, limps of natural soil is to be broke, and then sieving is done to remove larger particles. Then the homogenous mix is added in a cylindrical specimen (101.5 mm as dia, 117 mm as height, and 50mm as collar height on top) and the conventional method of tapping is done and in the last removal of mould is done. Then curing is taking place with moist jute bags for 28 days and air drying is done in the laboratory before testing of the specimen. By this study, the authors concluded that increasing the rate of spilt tensile strength is found to be the same but soil containing no fibre this rate is very low as compared to soil containing fibre. The author also saw that in non-stabilized raw soil if fibres are added show some amount of increment in tensile strength at low moulding pressure, while due to bond strength between soil and fibre at high moulding pressure, a huge increment in tensile strength is found due to the function of cement. Thus the author concluded that for increment tensile strength in plastic soil fibre and to improve ductility, the soil should be stabilized with cement.

Ingunza et al. [29] studies the use of the sewage sludge in mud bricks. The authors examines that the maximum of the sludge percentage that can be used in soft mud bricks that resulted in environment-friendly and technical bricks. The authors took two clays clay A (high plastic) and clay B and treated sludge (containing 50% less sio2 then clay) which is drained from a dry bed. This clay had a lower percentage of CaO and KO2 and a high percentage of Al2O3 and SiO2. The author finds out the best proportion of 2 clays i.e. 2:3 before the manufacturing of bricks. Then the bricks(220 × 105 × 45 mm) are manufactured in kiln with 5,10,15,20,25,30,35,40% sludge. The results obtained from observations showed that bricks containing more than 25% of sludge exhibit cracks, damaged corners and edges. He also examined that the 35% of sludge in bricks are brittle in nature while more than 40% of sludge made bricks are fractured so they are removed from the experiment. Bricks with 10 and 25% sludge showed a dramatic change in the dimensions. This study also showed that bricks made with 25 and 30% sludge meet the required standard. Bricks with 5% sludge showed a loss of 45% strength, while there is decrement of reduction in strength of bricks which are made from 10 and 20%, but still these bricks attained the minimum strength according to the norms. He also examined that the bricks made from sludge percentage of 15 and 20% are characterized as 2nd class brick. Thus in the last this study showed that the potential percentage of sludge that can be added in a mass to meet the desired standard is 20%.

Kazmi et al. [30] examined the study of using glass sludge (WGS) in the bricks made up of clay. The Waste Glass used in this study is collected from the glass industry while scaling of glass. Manufacturing of brick specimens is done by various dosages from 5 to 25% as an interval of 5% by clay weight of WGS in a kiln. Clay was collected from the local kiln.WGS is a white color residue that is obtained from the glass industry while the polishing process.mix is prepared by adding WGS and clay with different ratios. Then adding of water is done and mixing up to the achievement of homogenous mixture and the mix is added in a specific mould to make a brick of size 228 × 114 × 76 mm. After that bricks are dried for 3 days in sunlight under a shed and then dried bricks are burn in the kiln at 850°C for 36 hrs. In this study the composition was find out by using X-ray fluorescence, which shows that clay composed of 58.35% of silica and 2.71% of alumina and WGS composed of 62% of silica and some amount of oxides of sodium, calcium, magnesium, and aluminum. Authors found that loss of ignition is higher for WGS(24%) than clay(4%) which can increase the porosity of bricks. By this experiment authors found that due to the addition of WGS shrinkage reduced to a great extent i.e. brick specimen without WGS shows 5% of shrinkage and with WGS addition reduced to 3%. Also with the addition of WGS there is a decrement of Weight per unit area of brick which leads to lighter weight of bricks. By this he concluded s that WGS added brick leads to eco-friendly bricks and economical. When bricks are tested for compression, it shows that compressive strength without WGS has 10Mpa strength while WGS shows 13Mpa strength. Hence in last authors concluded that on adding WGS shrinkage reduced, the strength is increased, porosity decreased, the weight of bricks decreased, water absorption decreased, efflorescence decreased. Finally, authors concluded that WGS can be added in clay bricks in large production levels lead to more sustainable, eco-friendly and economical construction.

Research Gap

1. Waste crushed tiles result in high-grade concrete mix is least explored.
2. Combination of waste material (crumb rubber, Bagasse, Waste tiles) is not examined.
3. Stability of building is not checked by using Green concrete
4. Energy consumptions of buildings made from more than one waste material is not explored.

Research Objective

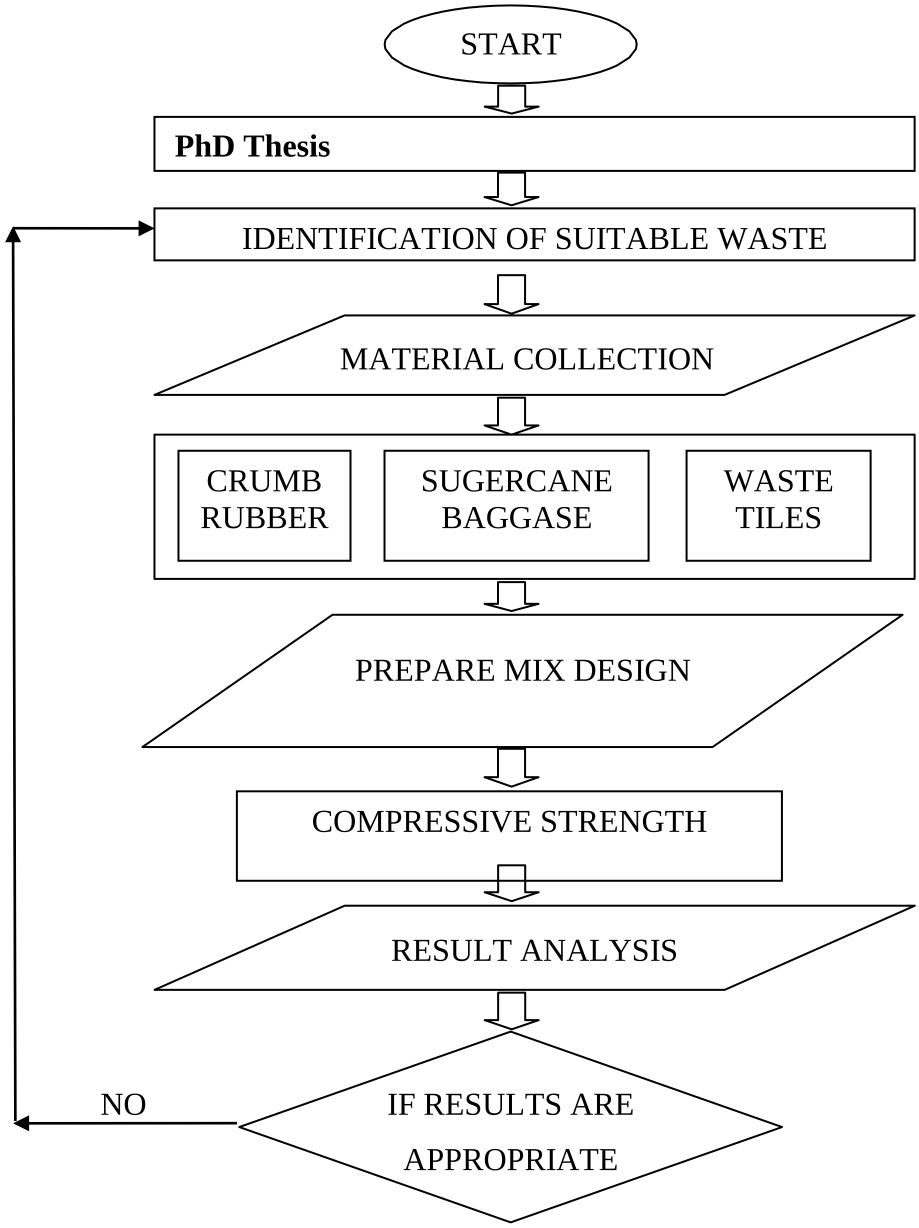
1. To investigate the influence of adding waste crushed tiles in concrete mix design in M40 grade.
2. To explore the effect on concrete strength by using more than one waste i.e. (Bagasse as binding material, waste crushed tiles as coarse aggregates and crumb rubber used in place of fine aggregate in the concrete)
3. To analyze the Stability of G+3 floor building by using various strength parameters of Green concrete in Stadd pro and find out which one is Stable amongst four Locations of India?
4. To analyze energy consumption of building by using strengths parameters of concrete made from these wastes in different climatic conditions of India by using Revit architecture and then Estimation of building is done through Estimator software between Zero energy building and Conventional one to find out which one is Economical?
5. To find out the Buildings Location out of four locations where it is more stable as well as Economical?

CHAPTER 3

METHODOLOGY

General

This investigation had begun with reviewing some of the esteem papers and the finding the latest trends in civil engineering. After choosing the theme I tackled the problems by examines different research papers related to this topic. After identifying the problem, the assembling of materials has begun. After the collection of all materials different laboratory tests are performed. The Project methodology is shown in fig 3.1. After testing results are going to be used in software for further research on energy analysis and cost estimation.



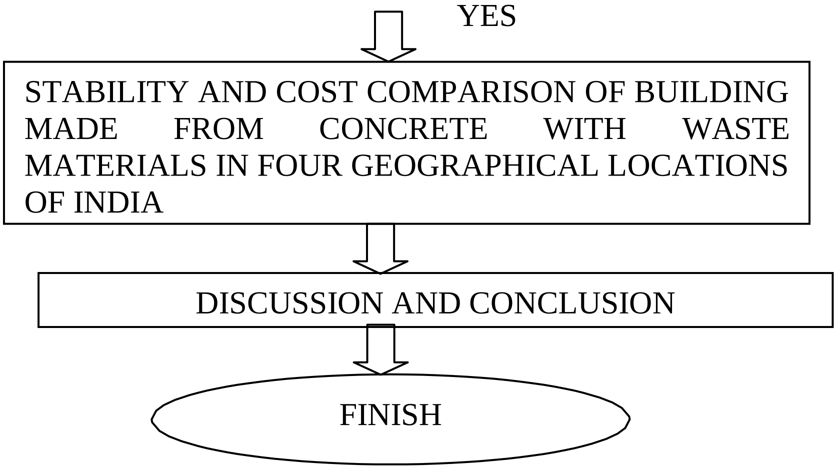


Fig. 3.1 Methodology of the project

Materials and Software Used

Following are some materials which I will be using in this research like cement, aggregates and some waste which I will be replacing as concrete components.

Cement

PPC (Portland Pozzolana) grade 33Mpa, (acc. to IS 1727: 1967) is taken as shown in fig 3.2. PPC cement is collected from a local shop.

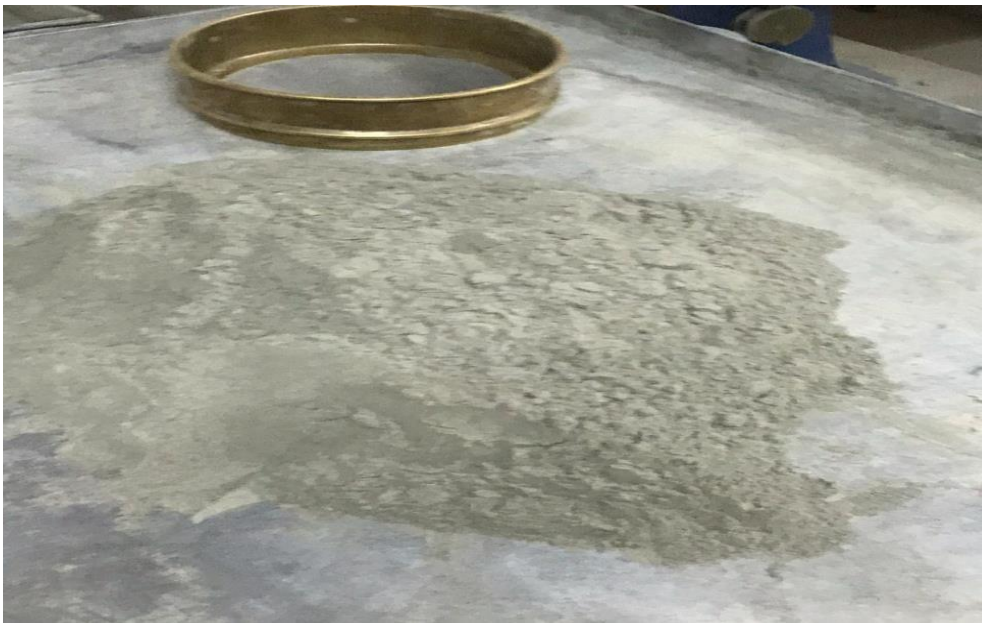


Fig. 3.2 Portland Pozalana Cement used at lab

Sand

Locally river sand was taken in the work. Further these aggregate was tested for their physical prperties according to IS: 2386-1963. In this study river sand of zone-1 and zone-2 is used as shown in fig 3.3

Fig. 3.3 Sand used for design mix

Coarse Aggregates

Aggregates less than 20mm of size is collected from the local crushing plants as shown in fig 3.4. Further these aggregates were tested for their physical properties before using.

Fig. 3.4 Coarse aggregate of 10mm and 12.5mm

Bagasse

Bagasse is the dry fibre that remains after extraction of juice from sugarcane. Recently, this by-product has drawn attention of the civil engineering practitioners due to its proper physical and chemical characteristics. In an ideal processing situation, bagasse ash has a high amount of amorphous silicate and a broad specific surface area which makes it an effective pozzolanic additive to improve the mechanical performance of the geomaterials. In this study baggase from Sandhar sugar mill Ltd. (Phagwara) as shown in fig 3.5

-

Fig. 3.5 Bagasse used as replacement of cement

Waste Crushed Tiles

Some mosaic tiles which are totally broken is collected from the dismantled strcuture. These tiles were squashed into little pieces by using a crusher. All aggregate of tiles passing through sieve of 16mm and retained over 12.5mm sieve are going to be used. In this study demolished tiles from nearby construction houses are collected as shown in fig. 3.6

Fig.3.6 Waste crushed tiles used as replacement of Coarse Aggregate

Crumb rubber

It is reused rubber created when scrap tires are repaired. During the reusing process of tyre, fibal product is tire rubber having a granular consistency. Crumb rubber is collected from local tire remolding shop as describe in fig 3.7

Fig. 3.7 Crumb rubber used for replacing Fine Aggregates

Superplasticizer (SP)

Superplasticizers (SP's) as shown in fig.3.8 also called as water reducers of high range. Superplasticizers help in reduction of water content up to 30% or more without in reduction of workability. Plasticizers and super-plasticizers retard the curing of concrete. The use of superplasticizers is used for the production of, self-compacting, and self-leveling and very high strength concrete.

Fig. 3.8 Superplasticizer used in design mix

Water

Water helps in achieving the strength of concrete. About 3/10th weight of water is going to be used for complete hydration. The minimum w/c ratio of 0.35 is required for conventional concrete. If excess of the water is going to be used, then the bleeding occurs, and further the concrete is found to be weak in strength. If water used is less, then the workability isn't accomplished. If water is to be used in concrete should have a pH range between 6 to 9.

Autodesk Revit Architecture

Revit is 3D modeling software that is considered one of many BIM tools. It is a step ahead of the traditional CAD software. The main advantage of Revit is not in the 3D aspect but the aggregated database and bidirectional associability. This means that everything is integrated and interrelated and a change will be reflected everywhere across the platform.

Autodesk Energy Analysis

Energy simulation can assist you with breaking down the development of energy through rooms in a structure model. Also this data can assist designers with improving educated, financially choices that improve the exhibition and decrease the ecological effect of structures. The energy simulation of building measures the expected use of energy according to building's dimensions, its environment, and the type of building, , and HVAC & Lighting systemof the house.

Estimator

Estimator is Software for the Architects, the Contractors and all Engineers who wants to do estimation. By Estimator one can make the Estimates of all types of residential as well as commercial buildings. We can also able to make Detailed Estimate by this software.

Stadd Pro

This software is used for the Analysis and designing of structure. This Software is the most utilized Software for structural building planning. Some of its advantages are:

- Does not include any manual computation
- Suitable for all type of materials for the designing purpose i.e. Concrete design, Steel design, Aluminum and many more
- Show all parameters of building components like shear force , bending moment etc.

Parameters of Experiment

Some list of Building Materials and IS Codes used:

1. Ordinary Portland Cement 43 - IS 8112:1989
2. Test for compression - IS 14858:2000
3. Coarse and fine aggregates Specific gravity – IS 2386-3 (1963)
4. Ideal thinking - IS code 456:2007

Testing

1. Cement Testing
2. Measure the property of crumb ruber in concrete mix.
3. Measure the property of waste crushed ceramic tiles in the concrete mix.
4. Measure the property of bagasse mixed concrete.
5. Measure the concrete properties by adding crumb ruber as sand, waste crushed ceramic tiles, bagasse as a binding material in the concrete mix with some replacement.

Some Tests Performed

Some tests were carried out on concrete they are given beneath:

Casting

Firstly prepared the mix for the combinations as introduced in chapter 4 and then the casting was carried out. The material mixing procedure is as follows.

1. Weighing of materials is done as per mix design.
2. Measure the required water for the mix along with superplasticizer.
3. Then the pouring of materials into the plate is done and dry mixing of materials for 2 minutes is done.
4. After that 70 % of the water is poured in to plate and 3 minutes mixing was done.
5. Now remaining water was added in to the mix for 3 min.
6. 150 x 150 x 150 mm molds is used for casting. Make sure that the nuts of molds were tightened properly to assure the proper dimensions. Allow vibration for 4-5 minutes.
7. After the casting of all cubes, kept them for 24 hours at the room temperature and then de-mold it and put in the water tank for up to twenty eight days.

Compression Strength Test

Different cubes for all mix designs were casted for every combination to obtain the average. Now compressive strength of all cubes was tested. The compressive testing is performed on the CTM as shown in fig. 3.9 with rate of approx. 1.8kN/mm²/min. After that all test cubes are withdrawn from curing tank, then let them dry in sunlight upto some time. The measurement of the cubes top and bottom were taken after drying. Then these cubes were placed on CTM bearing and the further the load application is continued up to the failure of cubes. Now,

Compressive strength = Load/Average area (MPa)

Fig. 3.9 Compression Testing Machine

Procedure for Mix Design

This Project target is to make M40 grade of concrete by following the guidelines of IS: 456-2000**.** By these codes, the qty. of 1m^3 concrete can be made and w/c ratio also taken from these IS codes as shown in Table 3.1

Table 3.1 Calculated Values of different Materials for design mix

S. No.	Materials as per (IS 456-2000)	Calculated Value (IS 10262:2009)
1.	Cement	398.57 kg.m^{-3}
2.	Water	139.5 kg.m^{-3}
3.	Fine Aggregates	850 kg.m^{-3}
4.	Coarse Aggregates	1081.836 kg.m^{-3}
5.	Chemical Admixture	0.006 kg.m^{-3}

Estimation of the Quantity of Concrete Mix

1. Mix Design for M 40 with Water Cement Ratio 0.35

Characteristics strength = f_{ck} + 1.65 s

Where s = 5 N / mm^2

So characteristics strength = 48.25 N / mm^2

According to IS : 10262 when using 20 mm aggregates take water = 186 Kg

Using super plasticizer reduction of water = 25% (according to IS : 10262)

So water = 75% of 186 kg =139.5 kg

As water cement ratio taken = 0.35

So cement (PPC) = water / 0.35 = 139.5 / 0.35 = 398.57 kg/m^3 (320 to 450 acc. to IS: 456)

Sand used is of zone 2

Now for 1m^3

Cement = 398.57 / (specific gravity x 1000) = 0.126 kg

Water = 139.5 / 1000 = 0.139 kg

Volume of Super plasticizer = 0. 006 m^3 (assumed)

Now Total aggregate Volume = 1- 0.126 – 01.39 – 0.006 = 0.729 kg

Coarse Aggregate Volume = 0.729*0.56*2.68*1000 = 1081.836 kg

Fine aggregate Volume = 0.729 *0.44*2.65*1000 = 850 kg

Now ratio of cement: fine: coarse = 1: 1.9: 2.6

2. Mix Design for M 40 with Water Cement Ratio 0.3

Characteristics strength =f ck + 1.65 s

Where s have a value of 5 N / mm 2

So characteristics strength = 48.25 N / mm 2

According to IS: 10262 when using 10 mm aggregates take water = 186 Kg

Using super plasticizer reduction of water = 30% (according to IS: 10262)

So water = 70% of 186 kg =130.20 kg

As water cement ratio taken = 0.3

So cement (PPC) = water / 0.3 = 130.20 / 0.3 = 434 kg/m 3 (320 to 450 acc. to IS: 456)

Sand used is of zone 1

Now for 1m 3

Cement = 398.57 / (specific gravity x 1000) = 0.137.7 kg

Water = 139.5 / 1000 = 0.130 kg

Super plasticizer Volume = 0.006 m^3 (assumed)

Now Total aggregate Volume = 1- 0.137.7 – 0.130 – 0.006 = 0.726 kg

Coarse Aggregate Volume = 0.726*0.6*2.69*1000 = 1054.34 kg

Fine Aggregate Volume = 0.726*0.4 *2.65*1000 = 770 kg

Now ratio of cement: fine: coarse = 1: 1.7: 2.6

3. Mix Design for M 40 with Water Cement Ratio 0.45 and without using super plasticizer and 10mm size nominal aggregate

Characteristics strength = fck + 1.65 s

Where s have value of 5 N / mm 2

So characteristics strength = 48.25 N / mm 2

According to IS: 10262 when using 10 mm aggregates take water = 180 Kg

As water cement ratio taken = 0.45

So cement (PPC) = water / 0.45 = 180 / 0.45 = 400 kg/m 3 (320 to 450 acc. to IS: 456)

Sand used is of zone 1

Now for 1m 3

Cement = 400 / (specific gravity x 1000) = 0.142 kg

Water = 180 / 1000 = 0.180 kg

Now Total aggregate Volume = 1- 0.142– 0.180 = 0.678 kg

Coarse Aggregate Volume = 0.678 *0.6*2.69*1000 = 1094.34 kg

Fine Aggregate Volume = 0.678*0.4*2.65*1000 = 718.68 kg

Now ratio of cement: fine: coarse = 1: 1.78: 2.72

After calculating the quantity of concrete the cubes are made for testing the concrete strength. Fig 3.11, 3.11, 3.12, shows the casting of concrete with different waste materials. After remolding , curing is done for 28 days as shown in fig. 3.13. Then the cubes should be dried in a dry condition as shown in fig 3.14, then the strength of cubes are measured by CTM as shown in fig. 3.15. Readings were taken when first crack propagates in cubes and cubes after cracks are shown in fig. 3.16, 3.17, 3.18 respectively.

Fig. 3.10 Bagasse is added in concrete mix

Fig. 3.11 Waste tiles is added in concrete mix

Fig. 3.12 Crumb rubber is mixed in concrete

Fig. 3.13 Curing of cubes in sunlight

Fig. 3.14 Curing of cubes after water

Fig. 3.15 Testing of cubes under CTM

Fig. 3.16 Waste tiles cube after cracks under CTM

Fig. 3.17 Crumb rubber cube after cracks under CTM

Fig. 3.18 Bagasse cube after cracks under CTM

CHAPTER 4

Result Analysis

General

To find out the suitability of used material different testing of materials is carried out. Various tests were performed for testing PPC and further the results were compared.

Table 4.1 Some Physical Properties of used Materials

S. No.	Experiments	Results for bag 1	Results for bag 2	Is code
1.	Normal consistency of Cement	33%	33%	IS: 4031: Part 4 1988
2.	Initial setting time of Cement	70 min	69 min	IS: 4031: Part5 1988
3.	Final setting time Cement	576 min	600 min	
4.	Compressive strength of cement for three days	21 N/mm^2	22 N/mm^2	IS: 1489-Part 1 1991
5.	for seven days	30.2 N/mm^2	29.7 N/mm^2	
6.	for twenty eight days	42 N/mm^2	41 N/mm^2	
7.	Specific gravity of cement	2.7	2.63	IS: 2720- Part 3
8.	Specific gravity of Coarse aggregates	2.67	2.69	IS: 2386-Part 3-1963
9.	Specific gravity of Fine aggregates	2.61	2.65	

I have made cubes from three different ratio and I have to choose only one which gives the maximum strength of cubes for M40 mix as shown in table 4.2

Table No. 4.2 Compressive Strength for M40 Cube Samples with various ratios

Sr. No.	Ratio C:CA:FA	7 days Strength (N/mm 2)	28 days Strength (N/mm 2)	W/C ratio	Super plasticizer Used
1.	1:1.9:2.6	25.21	42.76	0.35	Yes
2.	1:1.7:2.6	24.42	40.21	0.3	Yes
3.	1:1.78:2.72	22.82	39.21	0.45	Yes

The ratio that will be taken for the Design mix is one which shows the maximum strength of cubes i.e. 1:1.9:2.6. Now, 150mm of each side concrete cubes were casted to find out the concrete strength by replacement of Cement by Bagasse ash. Now, the compression strength is as given in table 4.2

Table no. 4.3 Compression strength when cement replaced with Bagasse ash for seven days

% Bagasse ash	Sample –I (MPa)	Sample – II (MPa)	Sample – III (MPa)	Average (MPa)
0%	26.32	27.11	27.19	26.87
5%	27.02	27.16	27.09	27.09
10%	27.22	27.66	27.02	27.30
15%	28.02	28.11	28.09	28.07
20%	26.41	26.37	25.96	26.24

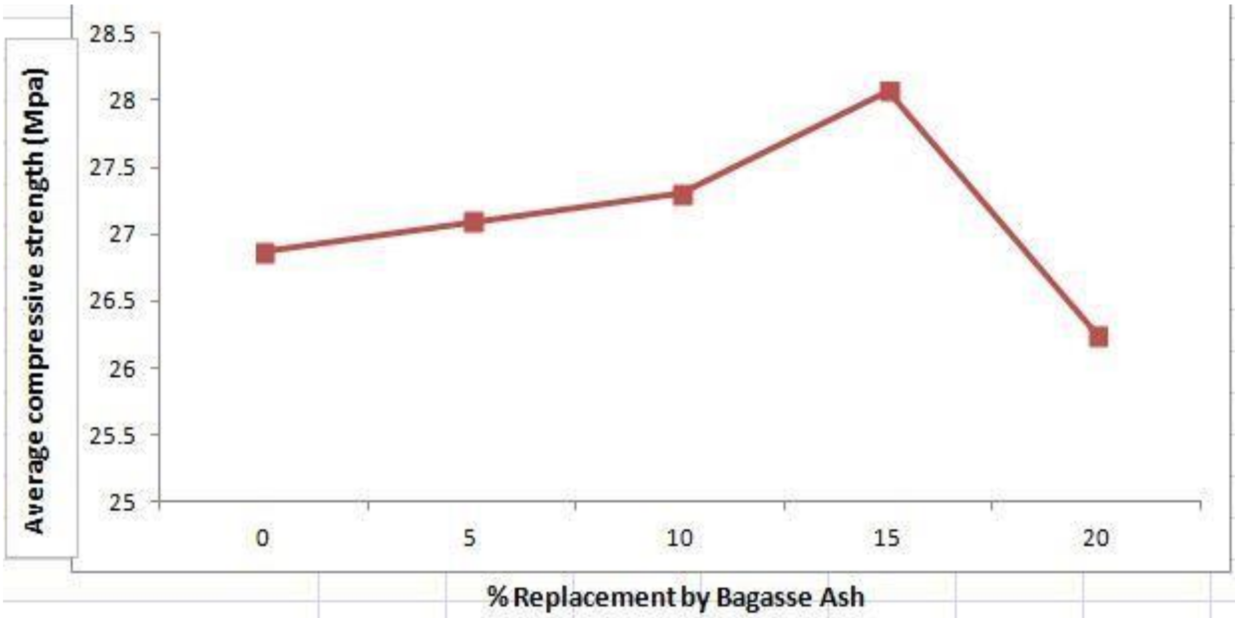


Fig 4.1 Compression strength variation with the %age of Bagasse ash for seven days

Fig 4.1 shows the 7 days Compression strength if we use Bagasse ash gives the ideal results, when the cement is replaced with 15%. Cement replacement with Bagasse ash at 15% gives maximum compressive strength. Hence 15% is the optimum value for cement replacement with Bagasse ash.

Table no. 4.4 Compression strength when cement replaced with Bagasse for 28 days

% Bagasse ash	Sample –I (MPa)	Sample – II (MPa)	Sample – II (MPa)	Average (MPa)
0%	40.52	42.07	41.77	41.45
5%	41.67	43.06	42.52	42.41
10%	43.02	42.80	42.73	42.85
15%	44.07	43.68	44.53	44.09
20%	40.17	40.24	40.18	40.19

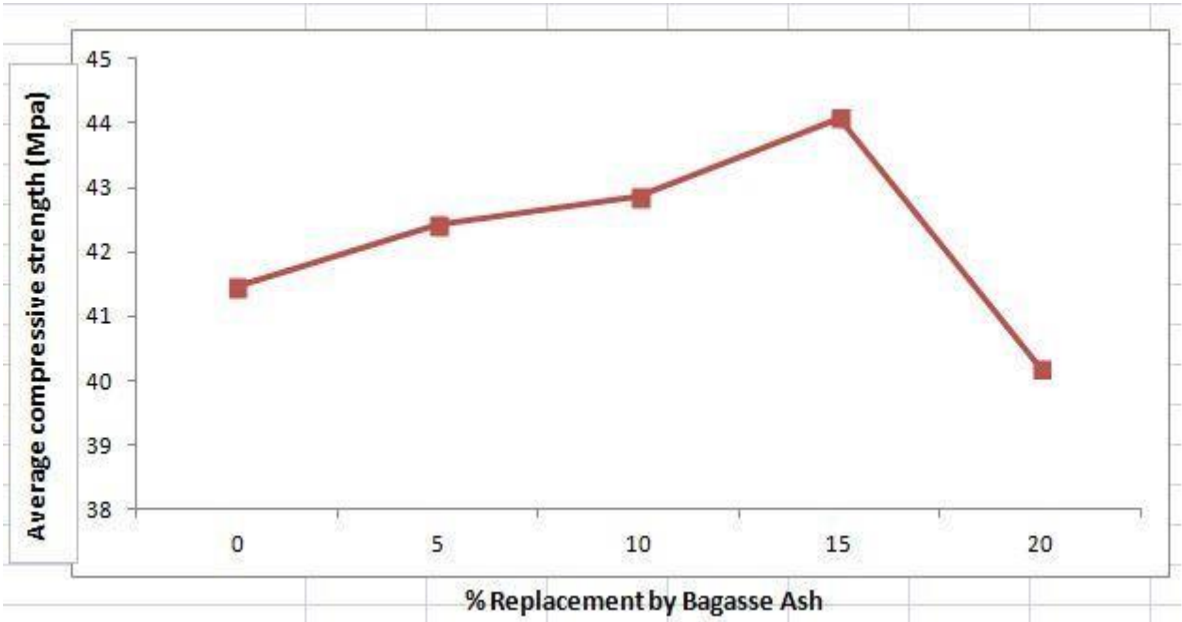


Fig 4.2 Compression strength variation with the %age of Bagasse ash for twenty eight days

Fig 4.2 shows the 28 days Compression strength if we use Bagasse ash gives the ideal results, when the cement is replaced with 15%. Cement replacement with Bagasse ash at 15% gives maximum compressive strength. Hence 15% is the optimum value for cement replacement with Bagasse ash.

Table no 4.5 Compression strength when Sand is replaced with Crumb rubber for seven days

% crumb rubber	Mix – 1 (MPa)	Mix – 2 (MPa)	Mix – 3 (MPa)	Average (MPa)
0%	26.88	27.03	27.57	27.16
1%	28.56	27.92	28.73	28.40
2%	30. 47	31. 24	30. 93	30.88
3%	26.22	26.84	27.01	26.69

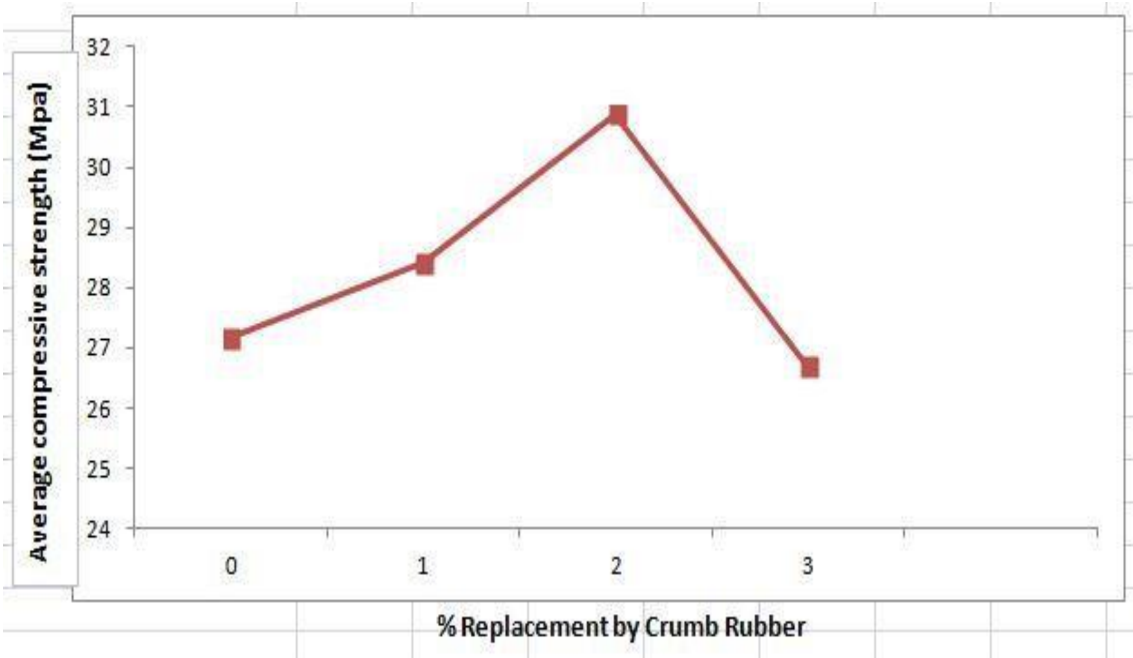


Fig 4.3 Compression strength variation with the %age of Crumb rubber for seven days

Fig 4.3 shows the 7 days Compression strength when Fine aggregates was replaced with 2%. Cement Replacement with Crumb Rubber at 2% gives the maximum compressive strength. Hence 2% is the optimum value for replacement of sand with Crumb Ruber

Table no. 4.6 Compression strength when Sand is replaced with Crumb rubber for twenty eight days

% crumb rubber	Mix – 1 (MPa)	Mix – 2 (MPa)	Mix – 3 (MPa)	Average (MPa)
0%	40.94	41.17	41.79	41.3
1%	42.15	41.97	42.35	42.15
2%	42.98	43.03	43.34	43.11
3%	41.03	40.91	40.88	40.94

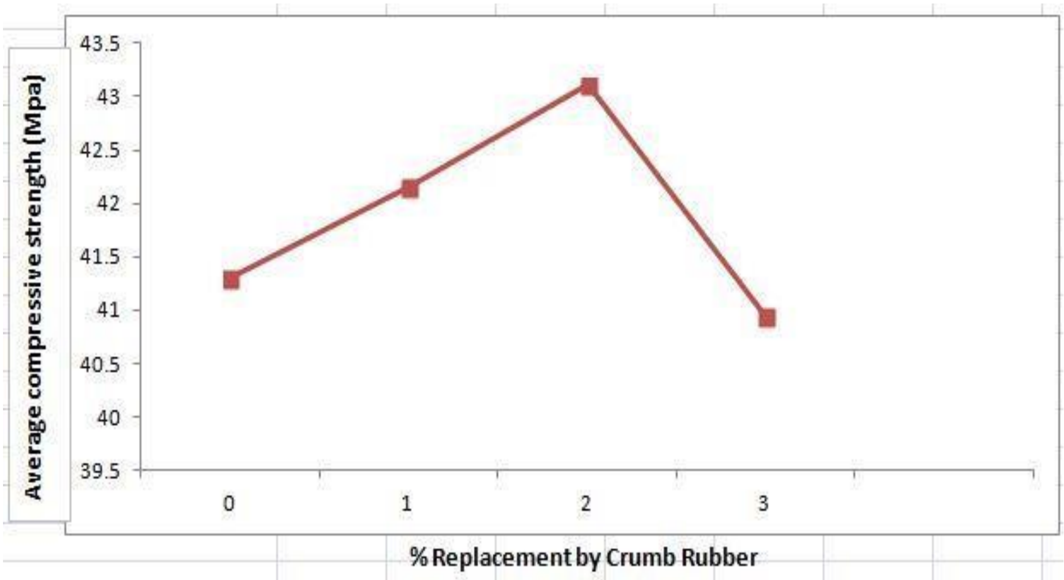


Fig 4.4 Compression strength variation with the %age of Crumb rubber for 28 days

Fig 4.4 shows the Compression strength for 28 days gives ideal results when Fine aggregates were replaced with 2%. Replacement of cement with Crumb Rubber at 2% gives the maximum compressive strength. Hence 2% is the optimum value for replacement of Fine aggregates with Crumb Rubber

Table no 4.7 Average Compression strength by replacing Waste tiles for seven days

% Waste tiles	Sample – I (MPa)	Sample – II (MPa)	Sample – III (MPa)	Average (MPa)
0%	26.22	26.41	27.03	26.55
5%	26.89	27.07	27.83	27.26
10%	28.93	29.08	29.59	29.20
15%	30.18	29.90	30.57	30.21
20%	29.09	28.85	28.94	28.96

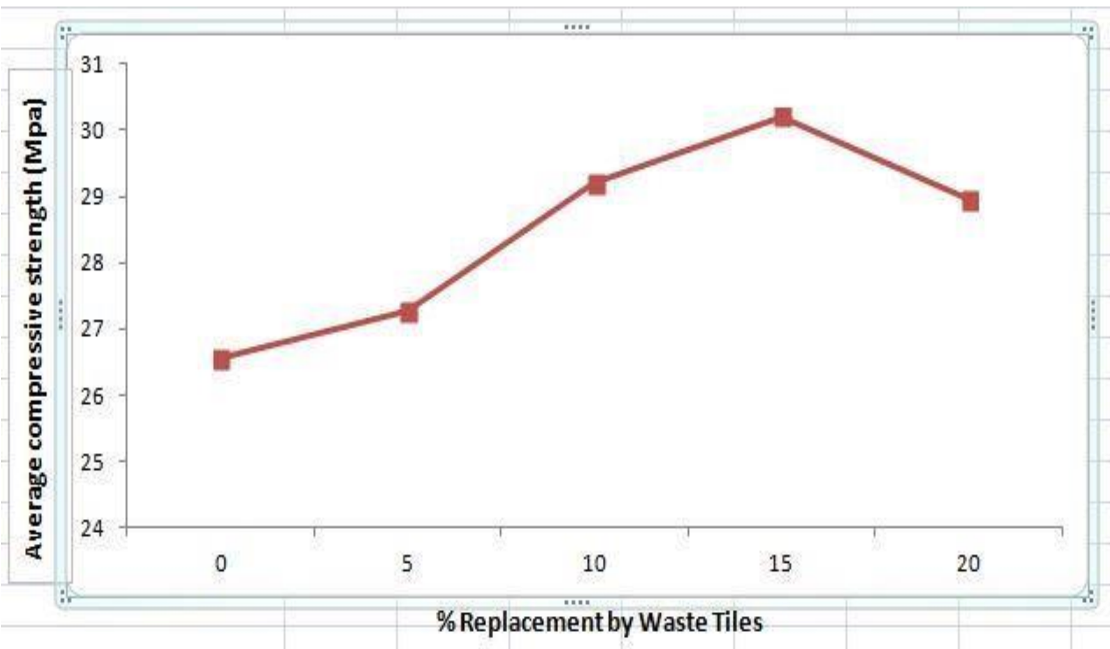


Fig 4.5 Compression strength variation with the %age of Waste tiles for seven days

Fig 4.5 shows the Compression strength for 7 days gives ideal results when Coarse aggregates were replaced with 15%. Replacement of the Coarse agregates with the Waste tile at 15% gives the maximum compressive strength. Hence 15% is the optimum value for replacement of coarse aggregates with Waste tiles.

Table no 4.8 Average Compression strength by replacing Waste tiles for 28 days

% Waste tiles	Sample –I (MPa)	Sample – II (MPa)	Sample – III (MPa)	Average (MPa)
0%	40.81	41.17	41.87	41.28
5%	42.91	43.06	43.14	43.07
10%	43.97	44.03	44.59	44.19
15%	45.93	46.17	46.83	46.31
20%	44.13	44.48	44.19	44.26

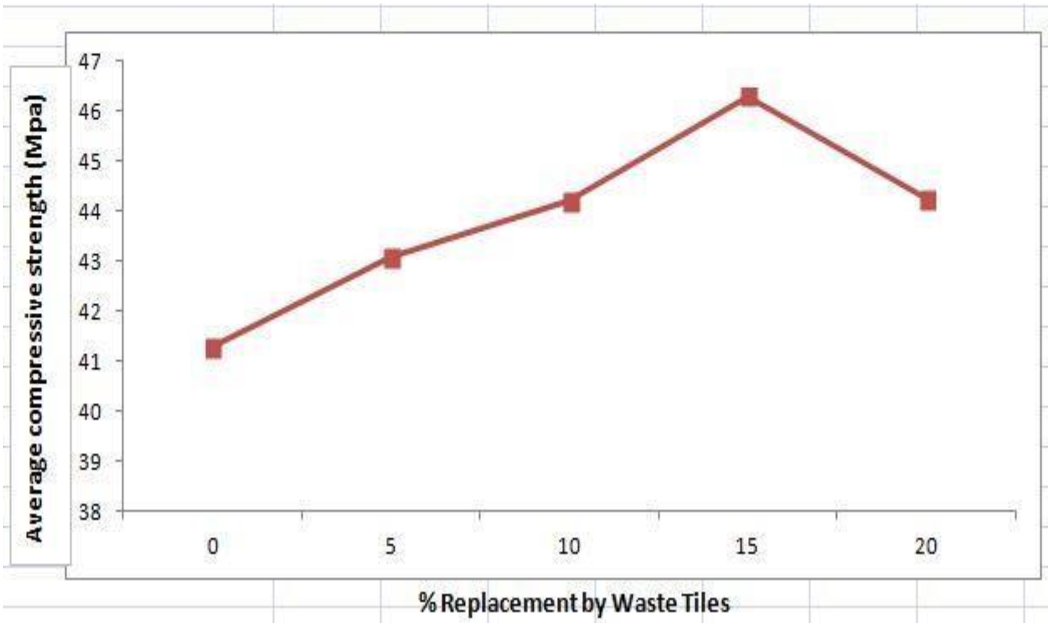


Fig 4.6 Compression strength variation with the % of Waste tiles for 28 days

Fig 4.6 shows the Compression strength for 28 days gives ideal results when Coarse aggregates were replaced with 15%. Replacement of the Coarse agregates with the Waste tile at 15% gives the maximum compressive strength. Hence 15% is the optimum value for replacement of coarse aggregates with Waste tiles.

Various combinations of waste material are replaced with some concrete components up to maximum percentage. In table 4.8 combination of compressive strength was shown as 5B5C5T, i.e.it mean 5% Bagasse ash, 5% Crumb rubber and 5% Tiles is used to cast cubes. As Fig 4.7 clearly depicts that 23% total replacement shows the maximum strength.

Table 4.9 Fluctuation in compression strength of cubes for 28 days

Combo %	**Mix number.**	**Sample – I**	**Sample – II**	**Sample – III**	**Average MPa**
0B0C0T	M0	42.44	45.7	44.32	44.70
0B1C0T	M1	45.28	43.40	47.80	45.75
0B1C5T	M2	41.76	42.62	40.24	41.54
0B1C10T	M3	39.74	41.61	40.03	40.43
0B1C15T	M4	40.91	45.16	43.43	43.14
0B1C20T	M5	42.55	45.38	46.33	44.74
0B2C0T	M6	43.65	44.87	44.62	44.38
0B2C5T	M7	43.91	44.52	45.31	44.58
0B2C10T	M8	40.20	41.12	39.90	40.40
0B2C15T	M9	46.20	42.18	43.34	43.96
0B2C20T	M10	43.80	42.34	45.80	43.98
0B3C0T	M11	38.48	40.37	42.36	40.40
0B3C5T	M12	39.59	41.73	40.28	40.53
0B3C10T	M13	43.59	40.79	41.37	41.96
0B3C15T	M14	43.72	43.59	42.89	43.40
0B3C20T	M15	44.72	42.51	41.53	42.92
5B0C0T	M16	41.64	40.96	42.65	41.75
5B1C0T	M17	42.74	43.01	41.77	42.50
5B1C5T	M18	39.90	38.62	40.15	39.55
5B1C10T	M19	40.77	38.91	37.65	39.11
5B1C15T	M20	44.90	45.15	44.42	44.82
5B1C20T	M21	44.56	45.37	45.32	44.71
5B2C0T	M22	43.75	44.87	44.62	44.41
5B2C5T	M23	43.81	44.32	45.11	44.41
5B2C10T	M24	40.36	40.12	39.80	40.09
5B2C15T	M25	44.20	43.98	44.64	44.27
5B2C20T	M26	43.80	42.74	44.80	43.78
5B3C0T	M27	40.48	40.37	41.36	40.73
5B3C5T	M28	40.59	40.73	41.28	40.86
5B3C10T	M29	40.59	40.79	41.37	40.91
5B3C15T	M30	43.72	43.59	42.89	43.40
5B3C20T	M31	43.90	44.15	44.42	44.15
10B0C0T	M32	44.56	45.27	45.22	45.01
10B1C0T	M33	43.65	44.77	44.22	44.21

10B1C5T	M34	43.71	44.34	44.11	44.05
10B1C10T	M35	40.26	40.02	39.70	39.99
10B1C15T	M36	44.10	43.88	44.24	44.07
10B1C20T	M37	43.57	43.74	44.70	44.00
10B2C0T	M38	40.38	40.74	41.26	40.79
10B2C5T	M39	40.29	40.63	41.48	40.8
10B2C10T	M40	40.46	40.67	41.46	40.86
10B2C15T	M41	42.46	43.37	43.32	43.05
10B2C20T	M42	43.85	44.17	44.32	44.11
10B3C0T	M43	43.91	44.22	44.31	44.14
10B3C5T	M44	40.10	41.02	39.90	40.34
10B3C10T	M45	46.20	42.18	43.34	43.90
10B3C15T	M46	43.90	43.64	44.80	44.11
10B3C20T	M47	41.08	41.67	42.26	41.67
15B0C0T	M48	39.59	40.73	40.28	40.2
15B1C0T	M49	41.59	40.69	41.27	41.18
15B1C5T	M50	42.72	43.29	42.69	42.9
15B1C10T	M51	43.72	43.51	42.93	43.38
15B1C15T	M52	41.84	41.66	42.55	42.01
15B1C20T	M53	42.74	43.31	43.77	43.27
15B2C0T	M54	40.58	40.64	41.16	40.79
15B2C5T	M55	40.92	40.73	41.38	41.01
15B2C10T	M56	40.36	40.57	41.36	40.76
15B2C15T	M57	46.31	45.23	47.98	46.50
15B2C20T	M58	43.72	43.59	42.89	43.40
15B3C0T	M59	43.90	44.45	44.42	44.15
15B3C5T	M60	44.56	45.27	45.22	45.01
15B3C10T	M61	43.65	44.77	44.22	44.21
15B3C15T	62	43.71	44.34	44.11	44.05
15B3C20T	M63	40.26	40.02	39.70	39.99
20B0C0T	M64	44.10	43.88	44.24	44.07
20B1C0T	M65	43.57	43.74	44.70	44.00
20B1C5T	M66	40.38	40.74	41.26	40.79
20B1C10T	M67	40.29	40.63	41.48	40.8
20B1C15T	M68	40.46	40.67	41.46	40.86
20B1C20T	M69	42.46	43.37	43.32	43.05
20B2C0T	M70	43.85	44.17	44.32	44.11
20B2C5T	M71	43.91	44.22	44.31	44.14
20B2C10T	M72	40.10	41.02	39.90	40.34
20B2C15T	M73	46.20	42.18	43.34	43.90
20B2C20T	M74	43.90	43.64	44.80	44.11
20B3C0T	M75	41.08	41.67	42.26	41.67
20B3C5T	M76	39.59	40.73	40.28	40.2
20B3C10T	M77	41.59	40.69	41.27	41.18
20B3C15T	M78	42.72	43.29	42.69	42.9
20B3C20T	M79	43.72	43.51	42.93	43.38

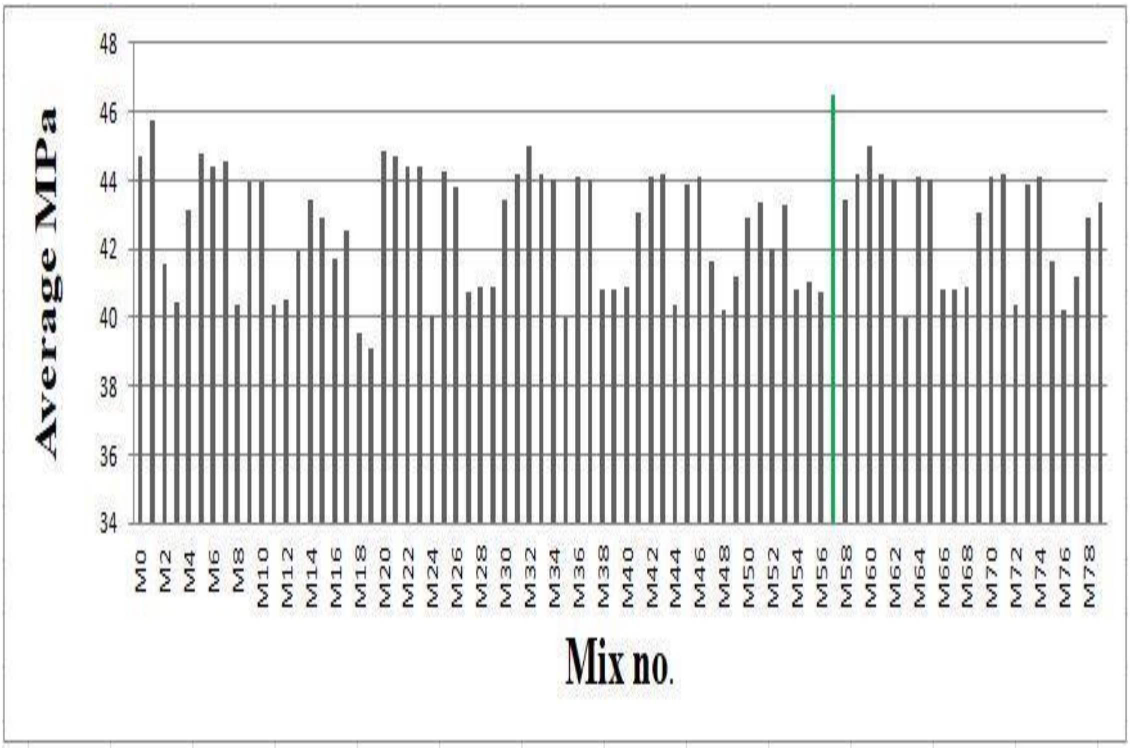


Fig 4.7 Graph showing compressive strength of different mix

Now,

Quantity of cement in $1m^3$ concrete = 398.57kg

No. of bags of cement in $1m^3$ concrete = 398.57 / 50 =8 bags

Cost of cement bags = 350 Rs (containing 50 kg quantity)

Cost of cement bags in $1m^3$ concrete = 8 x 350 Rs = 2800 Rs

Quantity of sand in $1m^3$ concrete = 850 kg

Cost of Sand = 1050 per tonne = Rs 1.05 (approx.)

Cost of sand for $1m^3$ concrete = (850 x 1050) / 1000

= 892.5 Rs ~ 893 Rs

Quantity of coarse aggregates in $1m^3$ concrete = 1081.8 kg

Cost of coarse aggregates = 750 kg per tonne = 0.75 Rs per kg

Cost of coarse aggregate for $1m^3$ concrete = (1081.8 x 750) / 1000

= 811.35 Rs ~ 812 Rs

Total cost of concrete (dry mix) = 812+893+2800 = 4500 per m^3

Replacement %age of bagasse as a replacement of cement = 15 % = 60 kg

Cost of bagasse = 2000 Rs per ton. = 2.2 Rs per Kg

Cost of bagasse as a replacement of cement= 60 x 2.2 = Rs. 132

Reduction in cement cost in $1m^3$ concrete = 60 x 7 per kg of cement

= Rs 420

Total saving when baggase is replaced with cement = 2800 - 420 + 132

= Rs.2512

Replacement % of crumb rubber as sand = 2 % = 17 kg

Market Price for crumb rubber = 0.5 Rs per kg

Market Price for rubber as a replacement of Sand= 17 x 0.5 = Rs. 8.5

Reduction in cost of sand in $1m^3$ concrete = Rs. 17 (approx.)

Total saving when Crumb rubber is replaced with Sand = 893 – 8.5 + 17

= Rs.902

Replacement percentage of the waste crushed tile as replacement of coarse aggregates = 15% = 163kg

Cost of waste crushed tiles = 2 per kg

Cost of waste crushed tiles as replacement with coarse aggregates = Rs. 363

Reduction in cost of Coarse aggregates in $1m^3$ concrete= 163 x 0.75 per kg of coarse aggregates = Rs. 123 (approx.)

Total saving when Waste tiles is replaced with coarse aggregates = 812 - 123 + 363 = Rs.1052

Table 4.10 Cost comparison between conventional concrete and green concrete for 1m^3 (excluding deduction of windows, doors, etc.)

Materials	Conventional concrete (Cost in Rupees)	Cost of Green concrete (Cost in Rupees)
Cement	2800	2512
Coarse aggregates	812	1052
Fine aggregates	893	902
Total cost	**4505**	**4466**

Amount saved = 39 Rs per meter cube
Now for 1410 sq ft. (131 meter square) assuming height of floor = 4 meter
Total area of one floor = 131 x 4 = 524 cubic meter
For four floors, Total area = 524 x 4 = 2096 cubic meter.
Amount saved = 2096 x 39 = Rs. 81,744

Software Part

In this part, G+3 floor building has been designed by using Revit software and then the building made from this green concrete as mentioned above is further checked for carbon emission and energy analysis by considering different factors in four regions of India.

Prototype-

- Designed for a family of Five for each floor i.e. total for 20 peoples with a plan, consisting of of a three bedrooms, living area, dining and kitchen, and two bathroom
- Windows are deliberately positioned to give satisfactory light as bigger windows are constructed on the north.

  • A chajja (an anticipating or overhanging roof) was presented on every four sides of the house to stop the sunlight into the house.

  • For roofing purpose a Galvanized Iron is used. This will helps in the house insulation. 2d building plan of one floor is shown in fig. 4.8 rest of all floors are same.
- I designed a building which is a Four storey building having area of 1410 Sq.ft, 3 BHK and would comfortably be able to accommodate 20 peoples i.e. 5 peoples per storey. Then the solar panels installation initially is going to be so much costly, but for the long run the owner of building would save lots of money from its energy bill. Also, in the deficiency of natural resources we can build a self-sufficient, energy-saving Building. On the back-side of the house, solar panels are installed, which

would be facing south. This helps in direct daylight to be consumed by the solar panels. Similarly windows on the southern side of building allow the most daylight to enter in the summer season and heat released from the living room/kitchen area.

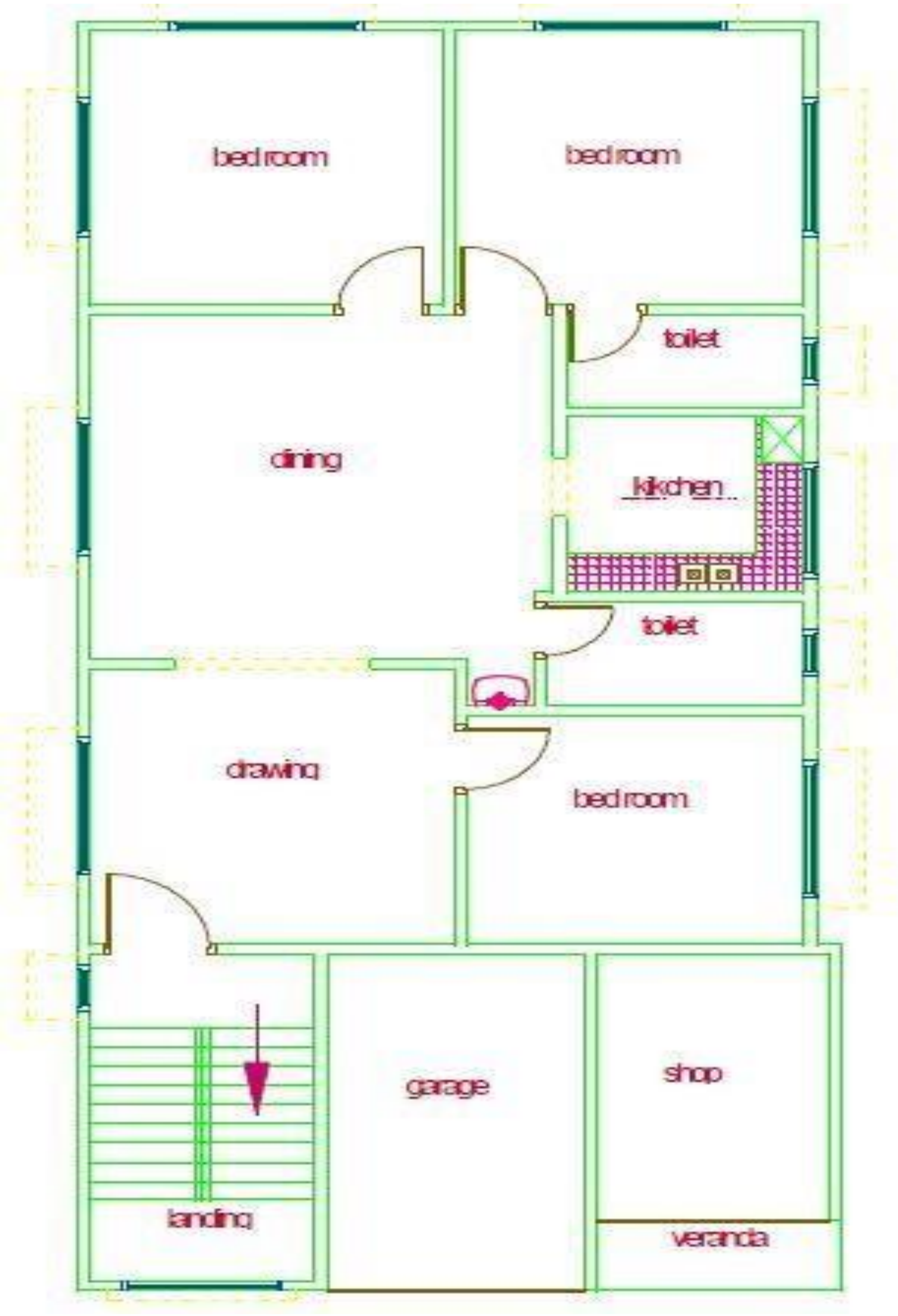


Fig 4.8 2d plan of one floor of G+3 building

Basic Parameters

Some basic parameters required for Energy calculations and Carbon emission are shown in fig- 4.9

- Building type – Choose the type of building like a hospital, motel, house, and multi-family house. I have chosen building type as multi-family house
- Building operating schedule- Choose the time for which the building is going to operate. I have chosen a 24/7 facility.
- Mode of energy analysis – I have chosen building element mode
- HVAC type- Residential 17 SEER/9.6 HSPF Split HP <5.5 ton
- Glazing percentage-. I have chosen this percentage at 40%
- Concrete grade – I have chosen M 40

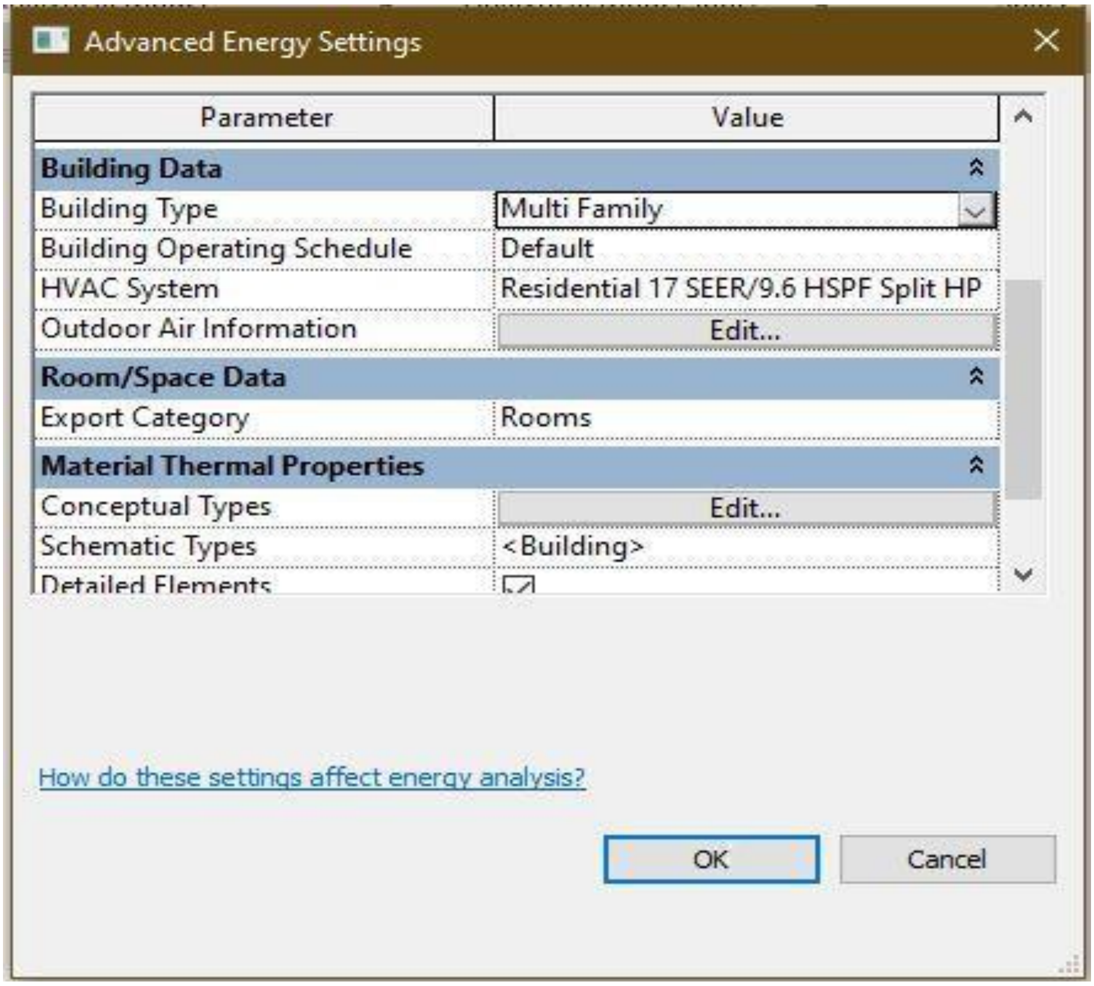


Fig.4.9 Parameters required for Energy calculations and Carbon emission in Revit

Carbon Emissions and Energy Analysis in North India (Kandaghat)

AUTODESK.

Analyzed at 12/2/2020 11:11:59

Result of Energy Analysis

Fig.4.10 Revit 3d G+3 Building plan in Kandaghat

Location:	27.08424949646,88.2693939208984
Weather Station:	456389
Outdoor Temperature:	Max: 80°F/Min: 37°F
Floor Area:	1410 sf
Exterior Wall Area:	1440 sf
Average Lighting Power:	0.60 W / ft²
People:	3 people
Exterior Window Ratio:	0.21
Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.78 / Therm

Fig.4.11 Performance Factors of the Building in Kandaghat

Life Cycle Electricity Use:	689,852 kWh
Life Cycle Fuel Use:	14,279 Therms
Life Cycle Energy Cost:	$30,136

*30-year life and 6.1% discount rate for costs

Fig.4.12 Life Cycle Energy Cost of Building in Kandaghat

Electricity EUI:	16 kWh / sf / yr
Fuel EUI:	33 kBtu / sf / yr
Total EUI:	86 kBtu / sf / yr

Fig.4.13 Intensity of used Energy of Building in Kandaghat

Roof Mounted PV System (Low efficiency):	4,633 kWh / yr
Roof Mounted PV System (Medium efficiency):	9,267 kWh / yr
Roof Mounted PV System (High efficiency):	13,900 kWh / yr
Single 15' Wind Turbine Potential:	353 kWh / yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Fig.4.14 Renewable Energy Potential of Building in Kandaghat

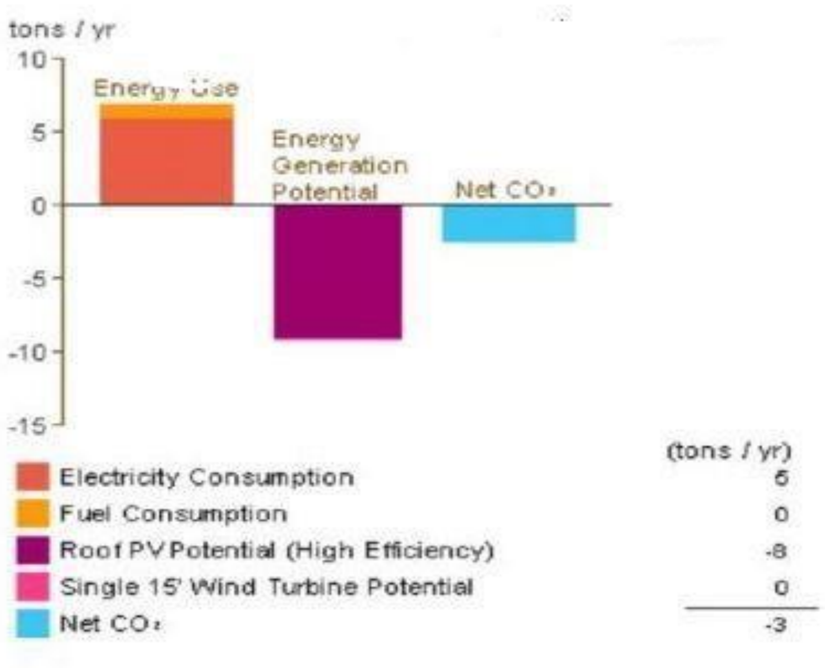


Fig.4.15 Carbon emission of building in Kandaghat

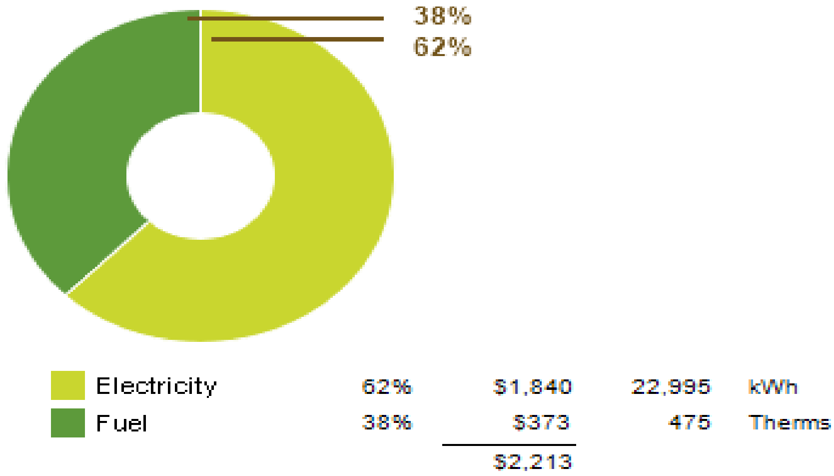


Fig.4.16 Annual cost of Energy use of building in Kandaghat

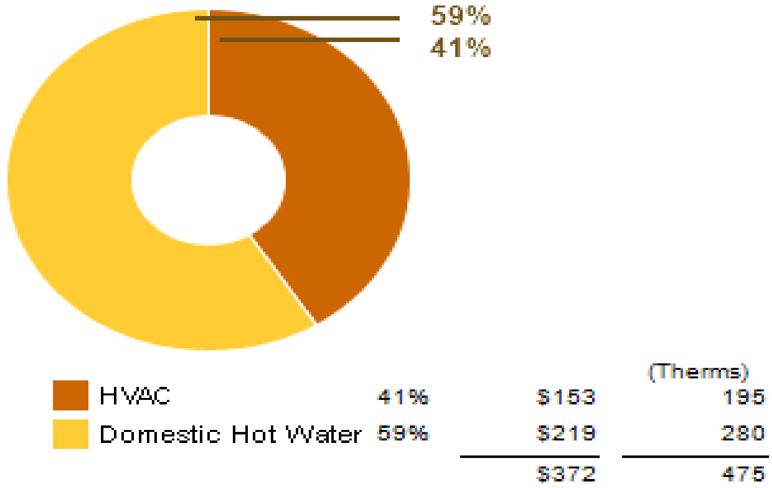


Fig.4.17 Use of Energy as fuel of building in Kandaghat

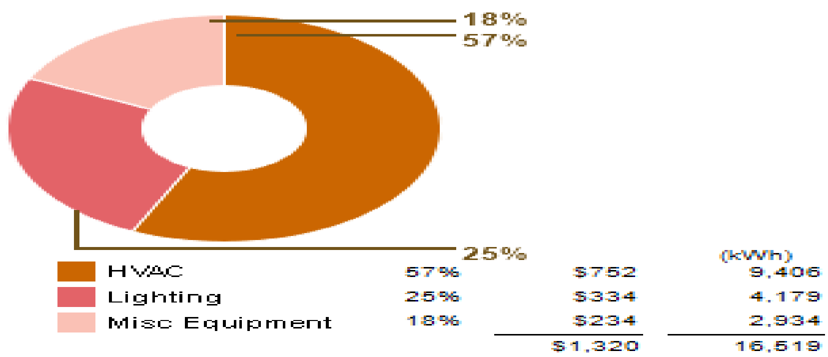


Fig.4.18 Use of Energy as Electricity of building in Kandaghat

Carbon Emissions and Energy Analysis in South India (Kerala)

AUTODESK.

Coastal
Kerala
Analyzed at 22/02/2020 11:46:31

Result of Energy Analysis

Fig.4.19 Revit 3d G+3 Building plan in Kerala

Location:	9.81571292877197,76.935676574707
Weather Station:	717157
Outdoor Temperature:	Max: 88°F/Min: 58°F
Floor Area:	1410 sf
Exterior Wall Area:	1440 sf
Average Lighting Power:	0.60 W / ft²
People:	3 people
Exterior Window Ratio:	0.21
Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.78 / Therm

Fig.4.20 Performance Factors of the Building in Kerala

Life Cycle Electricity Use:	571,832 kWh
Life Cycle Fuel Use:	5,977 Therms
Life Cycle Energy Cost:	$22,896

*30-year life and 6.1% discount rate for costs

Fig.4.21 Life Cycle Energy Cost of Building in Kerala

Electricity EUI:	13 kWh / sf / yr
Fuel EUI:	14 kBtu / sf / yr
Total EUI:	58 kBtu / sf / yr

Fig.22. Intensity of used Energy of building in kerala

Roof Mounted PV System (Low efficiency):	4,633 kWh / yr
Roof Mounted PV System (Medium efficiency):	9,267 kWh / yr
Roof Mounted PV System (High efficiency):	13,900 kWh / yr
Single 15' Wind Turbine Potential:	353 kWh / yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Fig.4.23 Renewable Energy Potential of building in Kerala

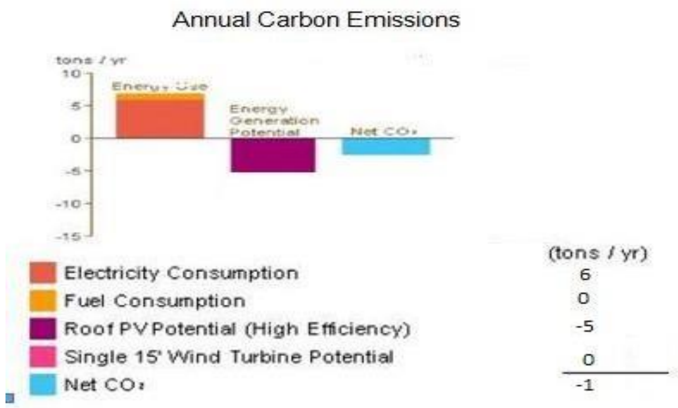


Fig.4.24 Carbon emission of building in Kerala

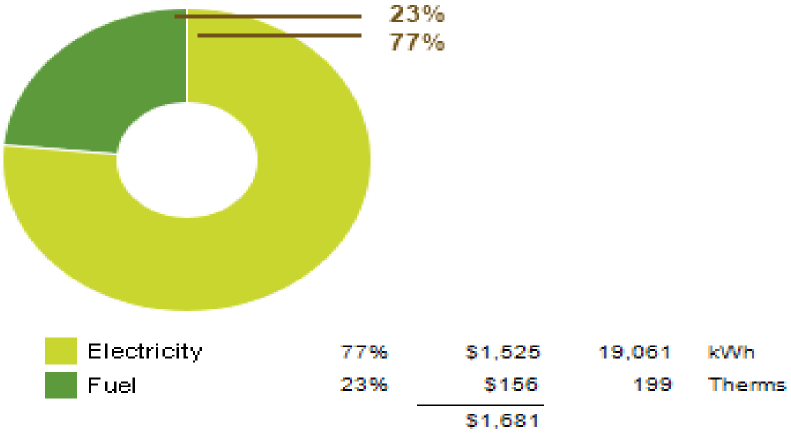


Fig.4.25 Annual cost of Energy use of building in Kerala

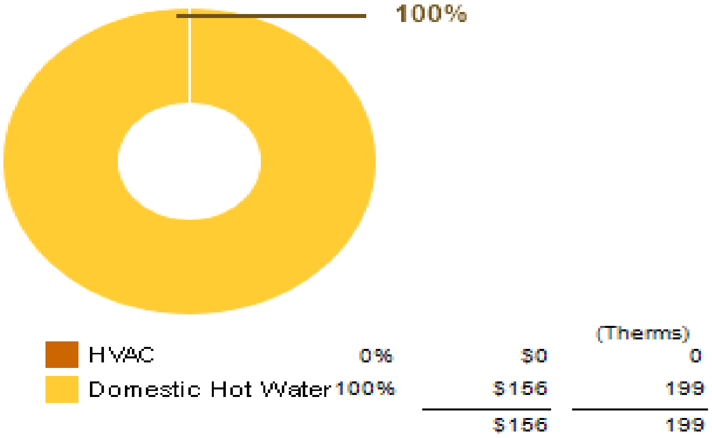


Fig.4.26 Use of Energy as fuel of building in Kerala

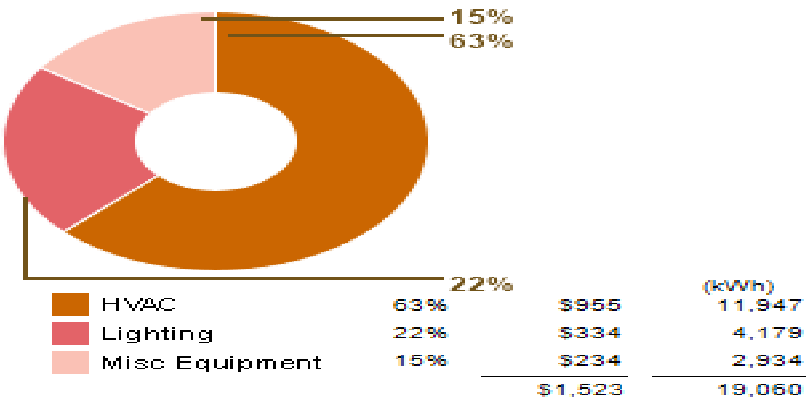


Fig.4.27 Use of Energy as Electricity of building in Kerala

Carbon Emissions and Energy Analysis in East India (Darjeeling)

AUTODESK.

Darjeeling east

Analyzed at 12/03/2019 2:36:39

Result of Energy Analysis

Fig.4.28 Revit 3d G+3 Building plan in Darjeeling

Location:	27.08424949646,88.2693939208984
Weather Station:	456389
Outdoor Temperature:	Max: 80°F/Min: 37°F
Floor Area:	1410 sf
Exterior Wall Area:	1440 sf
Average Lighting Power:	0.60 W / ft²
People:	3 people
Exterior Window Ratio:	0.21
Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.78 / Therm

Fig.4.29 Performance Factors of the Building in Darjeeling

Life Cycle Electricity Use:	495,614 kWh
Life Cycle Fuel Use:	10,831 Therms
Life Cycle Energy Cost:	$21,854

*30-year life and 6.1% discount rate for costs

Fig.4.30 Life Cycle Energy Cost of Building in Darjeeling

Electricity EUI:	11 kWh / sf / yr
Fuel EUI:	25 kBtu / sf / yr
Total EUI:	64 kBtu / sf / yr

Fig.4.31 Intensity of used Energy of the Building in Darjeeling

Roof Mounted PV System (Low efficiency):	4,363 kWh / yr
Roof Mounted PV System (Medium efficiency):	8,726 kWh / yr
Roof Mounted PV System (High efficiency):	13,089 kWh / yr
Single 15' Wind Turbine Potential:	171 kWh / yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Fig.4.32 Renewable Energy Potential of Building in Darjeeling

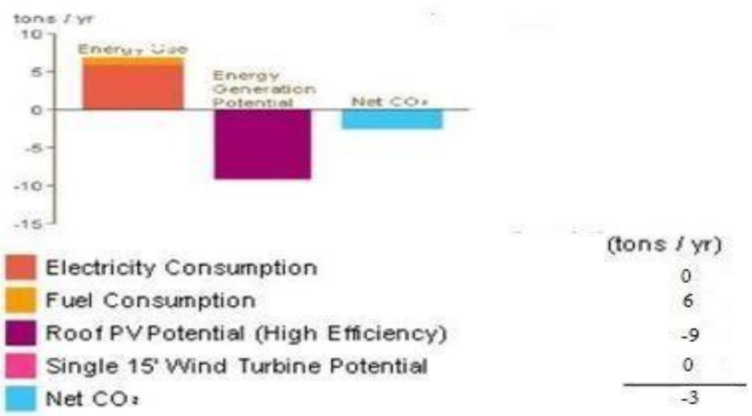


Fig.4.33 Carbon emission of building in Darjeeling

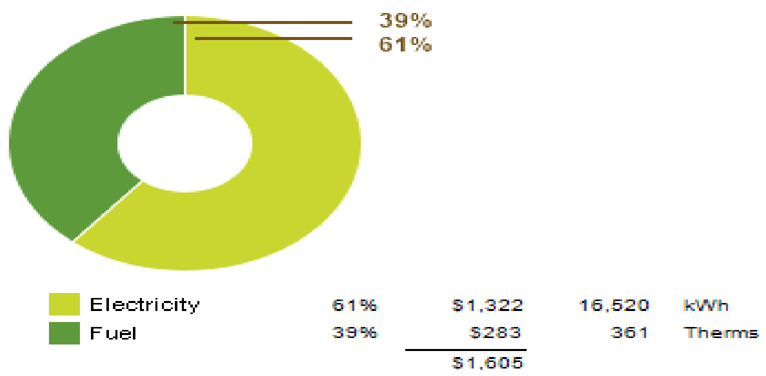


Fig.4.34 Annual cost of Energy use of building in Darjeeling

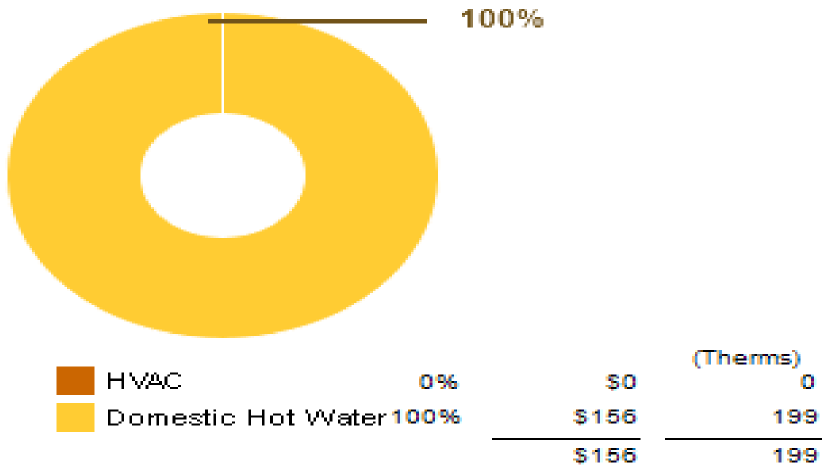


Fig.4.35 Use of Energy as fuel of building in Darjeeling

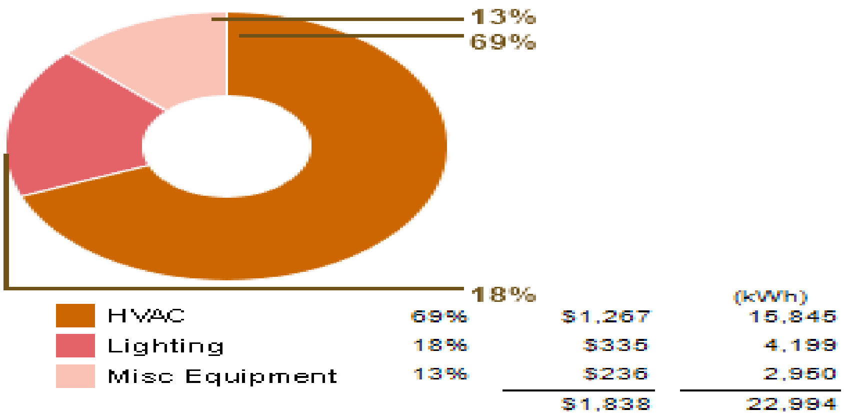


Fig.4.36 Use of Energy as Electricity of building in Darjeeling

Carbon Emissions and Energy Analysis in West India (Ganganagar)

AUTODESK.

Ganganagar
Analyzed at 1/03/2020 1:37:08

Result of Energy Analysis

Fig.4.37 Revit 3d G+3 Building plan in Ganganagar

Location:	30.6183795928955,74.8193130493164
Weather Station:	713182
Outdoor Temperature:	Max: 114°F/Min: 28°F
Floor Area:	1410 sf
Exterior Wall Area:	1440 sf
Average Lighting Power:	0.60 W / ft²
People:	3 people
Exterior Window Ratio:	0.21
Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.78 / Therm

Fig.4.38 Performance Factors of the Building in Ganganagar

Life Cycle Electricity Use:	633,525 kWh
Life Cycle Fuel Use:	5,645 Therms
Life Cycle Energy Cost:	$25,018

*30-year life and 6.1% discount rate for costs

Fig.4.39 Life Cycle Energy Cost of Building in Ganganagar

Electricity EUI:	15 kWh / sf / yr
Fuel EUI:	13 kBtu / sf / yr
Total EUI:	62 kBtu / sf / yr

Fig.4.40 Life Cycle Energy Used and Cost of the Building in Ganganagar

Roof Mounted PV System (Low efficiency):	4,363 kWh / yr
Roof Mounted PV System (Medium efficiency):	8,726 kWh / yr
Roof Mounted PV System (High efficiency):	13,089 kWh / yr
Single 15' Wind Turbine Potential:	171 kWh / yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Fig.4.41 Renewable Energy Potential of Building in Ganganagar

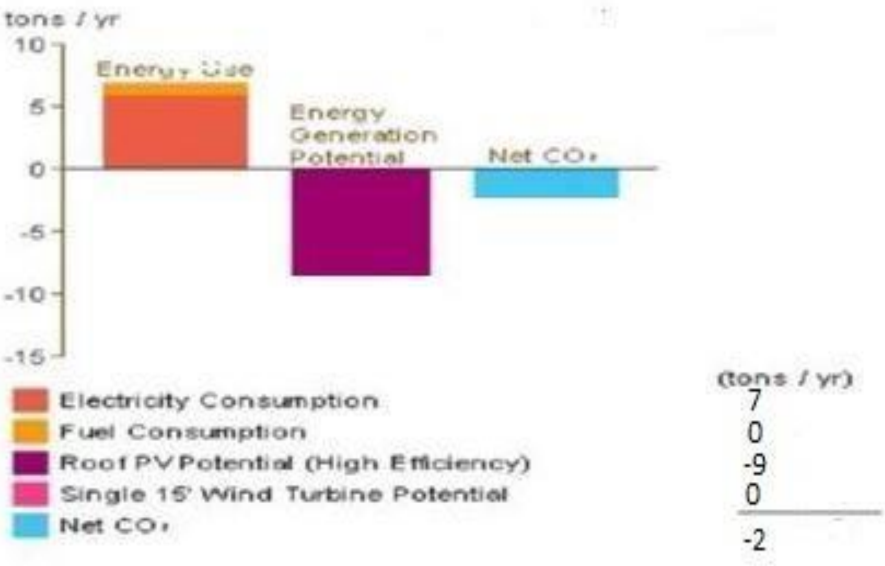


Fig.4.42 Carbon emission of building in Ganganagar

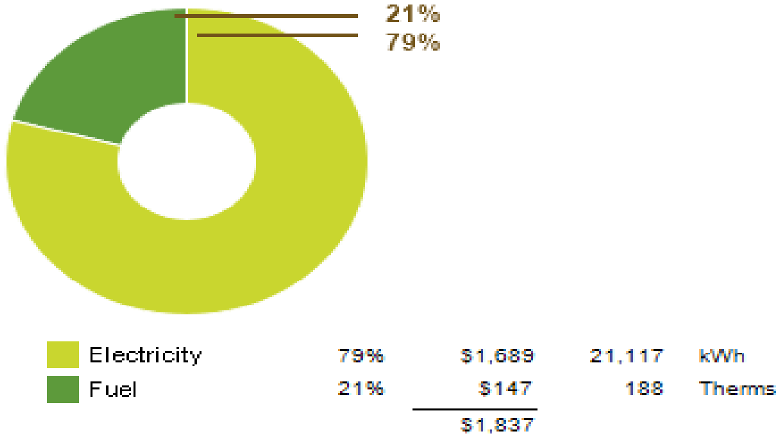


Fig.4.43 Annual cost of Energy use of building in Ganganagar

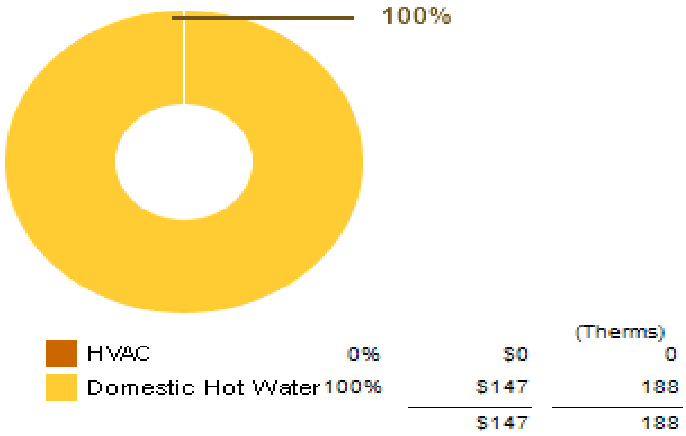


Fig.4.44 Use of Energy as fuel of building in Ganganagar

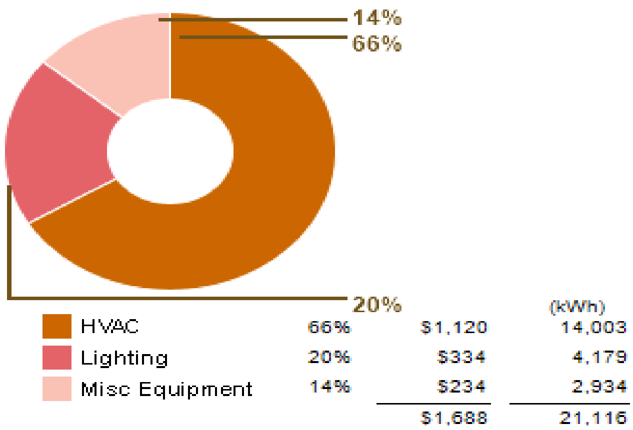


Fig.4.45 Use of Energy as Electricity of building in Ganganagar

Calculation of overall energy consumed by the building

As if the building is zero energy, the consumption of total energy is going to be nearly equal to zero.

Total energy utilization of the building in North India

As From the output of Revit we have

The building's electric consumption = 16,500 KWH/yr.

So, converting 16500KWH/yr into KBtu we get KBtu (1KWH/yr = 3.412 KBtu)

The EUI = 56,928 KBtu/1410gs= 40.37 KBtu/gsf

Total energy utilization of the building in South India

As From the output of Revit we have

The building's electric consumption = 19,000 KWH/yr.

So, converting 19000KWH/yr into KBtu we get KBtu (1KWH/yr = 3.412 KBtu)

The EUI = 64,828 KBtu/1410gs= 45.97 KBtu/gsf

Total energy utilization of the building in East India

As From the output of Revit we have

The building's electric consumption = 21,000 KWH/yr. As the energy use intensity (EUI) is express in terms of Kbtu/gsf (Btu = British thermal unit, gsf = Gross square feet are)

So, converting 21000KWH/yr into KBtu we get Kbtu (1KWH/yr = 3.412 KBtu)

The EUI = 71,652 Kbtu/1410gs= 50.8 Kbtu/gsf

Total energy utilization of the building in West India

As From the output of Revit we have

The building's electric consumption = 22,000 KWH/yr.

So, converting 22000KWH/yr into KBtu we get KBtu (1KWH/yr = 3.412 KBtu)

The EUI = 75,064 KBtu/1410gs= 53.23 KBtu/gsf

Stability analysis of Building in Stadd pro.

G+3 Floor building as shown in Fig. 4.49 is being analyzed in Different location of India. This stability is analyzed on the basis of Earthquake Analysis of the building. For every Location different values like Earthquake zone value, type of soil, damping ratio an importance factor etc. are given to find out the time as show in fig 4.50.

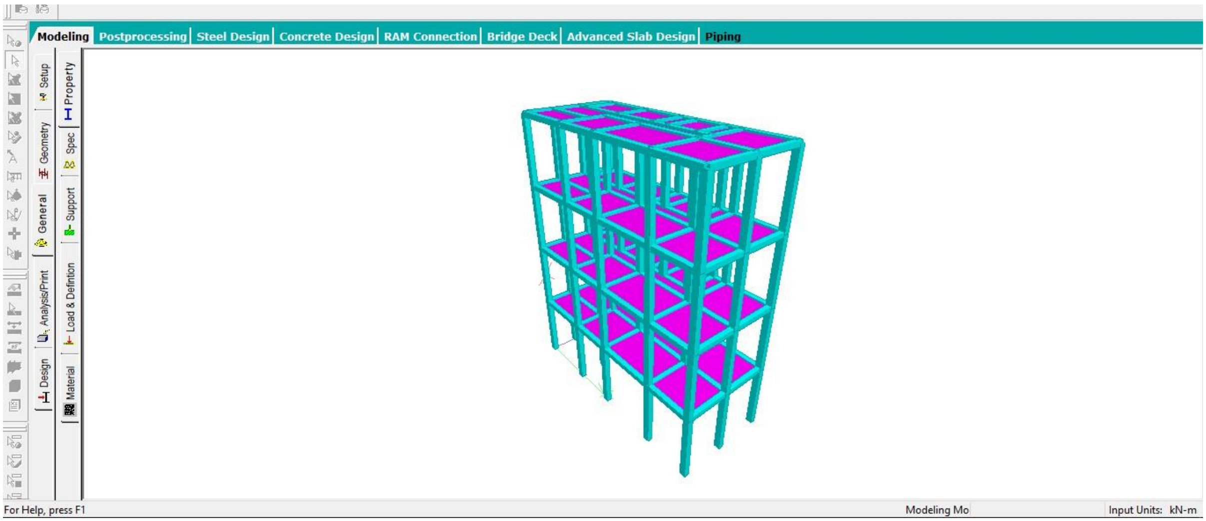


Fig.4.46 Rendered view of G+3 floor building in Stadd.pro

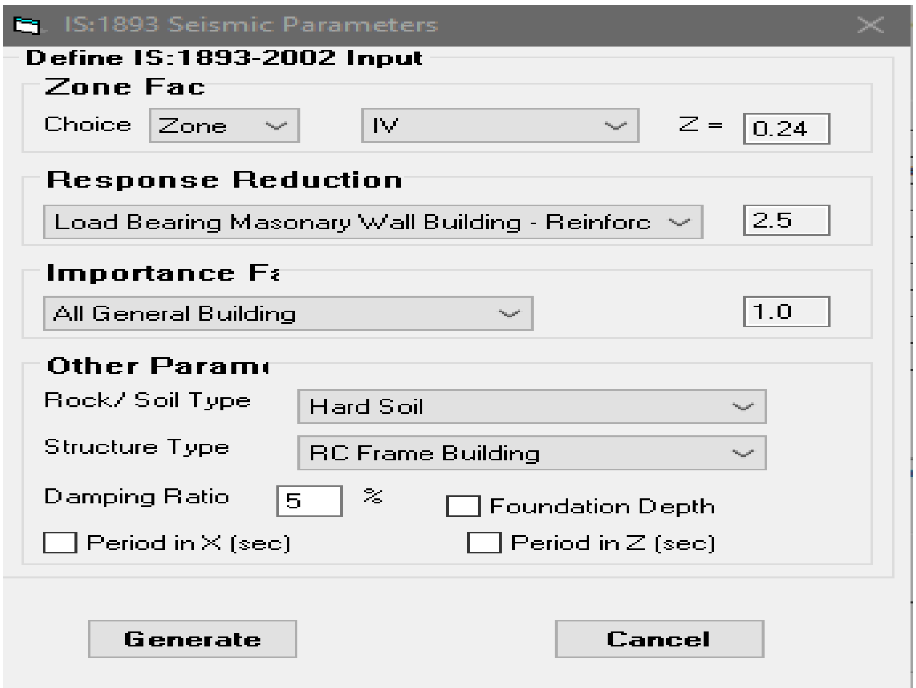


Fig.4.47 Seismic Parameters of G+3 floor building in Stadd.pro in Kandaghat

```
**********************************************************
*                                                        *
* TIME PERIOD FOR X 1893 LOADING =    0.23450 SEC        *
* SA/G PER 1893=    1.250, LOAD FACTOR=-1.000            *
*      FACTOR V  PER 1893=    0.0200 X   3471.34         *
*                                                        *
**********************************************************
```

Fig.4.48 Time Period of G+3 floor building in Stadd.pro in Kandaghat

Table 4.11 Comparison of Stability of G+3 Building in four location of India

S.no	**Parameters for G+3 Building**	**North India (Kandaghat)**	**South India (Kerala)**	**West India (Ganganagar)**	**East India (Darjeeling)**
1.	Zone Number	Zone IV	Zone III	Zone II	Zone IV
2.	Zone Factor	0.24	0.16	0.1	0.24
3.	Importance Factor	1	1	1	1
4.	Building Type	General	General	General	General
5.	Soil Type	Hard	Medium	Soft	Hard
6.	Damping Ratio	5	5	5	5
7.	Structure Type	RC Frame Building	RC Frame Building	RC Frame Building	RC Frame Building
8.	Response Reduction Factor (Load Bearing masonary wall building)	2.5	2.5	2.5	2.5
9.	Calculated time period For G+3 builiding from Stadd.	0.235	0.34	0.4	0.235

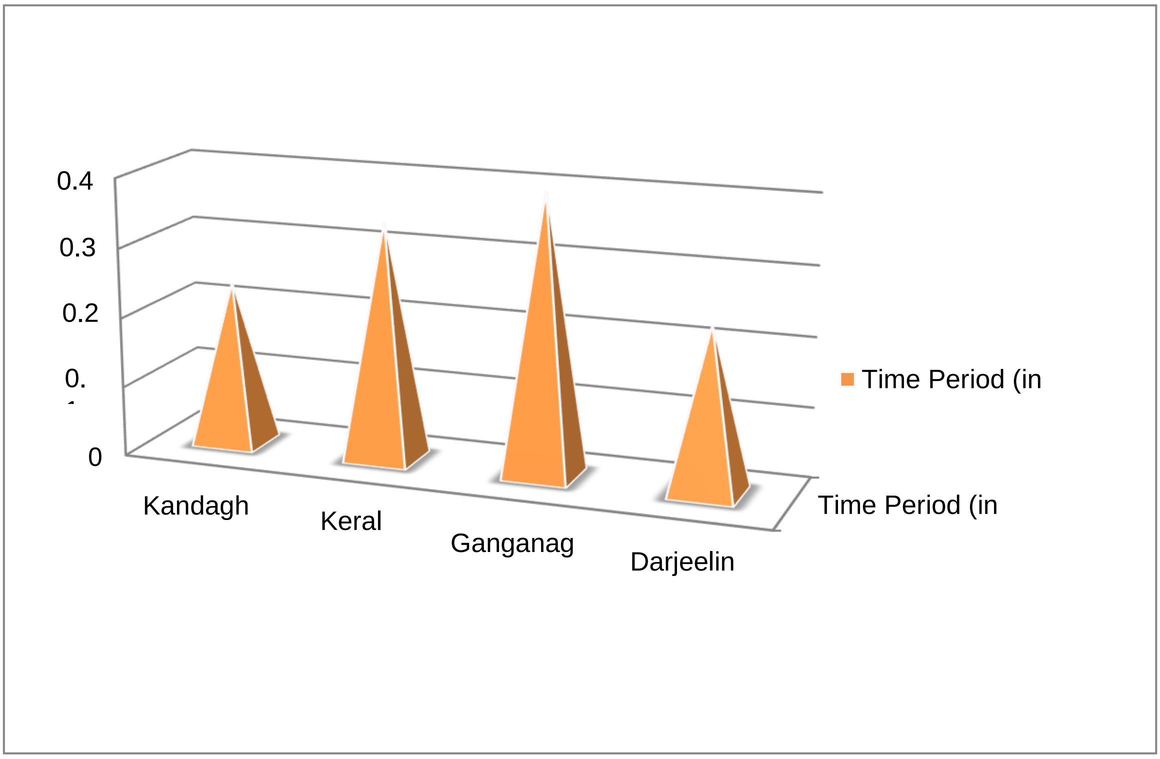


Fig.4.49 Comparison of Time period of G+3 Building in Four regions of India

As if time period is more stiffness is more and the structure is called to be brittle in behavior and at time of Earthquake we need a ductile type of Behavior in Buildings. So we can say that the building having less time period is said to be more stable.

From table, the time period for G+3 Building in North India (Kandaghat) and East India is same and less amongst all as they belongs from same zone and have same properties so the Building is said to be more stable in North and East India. Now for deciding the particular location out of two I will look into the economy part of this building by doing Estimation as shown below.

Approximate Cost of Conventional Building (excluding foundation work)

Construction cost estimation is the process of finding the cost of building. I did the estimation in Estimator 2.0 Software by adding all the physical requirement of buildings like Length breadth height of walls columns beams stairs PCC flooring Painting etc. as shown in table 4.9 to 4.12

Table 4.12 Cost Estimation for Ground floor by Estimator software

S.no	Description	Quantity	Unit	Rate	Amount
		Ground Floor			
	PCC				
1.	PCC flooring 1:4:3	108.43	Cu. m	2763.00	296664.48
		95.27 /Sq.m			296664.48
	RCC				
2.	RCC column Ready Mix	8.61	Cu. m	3828.00	32959.00
3.	RCC Beam Ready Mix	4.81	Cu. m	4050.00	19480.50
4.	RCC Steps Ready Mix	3.24	Cu. m	3000.00	9720.00
		19.96 /Sq.m			62159.58
	FORM WORKS				
5.	FORM WORKS RCC	898.46	Sq. m	150	134769.00
		43.28 /Sq.m			134769.00
	Steel Requirements				
6.	Steel Requirements	3353.95	Kg	30.00	100618.50
		32.31 /Sq.m			100618.50
	Brick works				
7.	Brick works CM 1:6	72.81	Cu. m	2278.00	165861.18
		53.26 /Sq.m			165861.18
	Floor and wall finishes				
8.	Wall finishing marble tiles	8.10	Sq. m	500	4050.00
		1.3 /Sq.m			4050.00
	Doors and window				
9.	Frameswood	0.83	Cu. m	27840.00	23107.20

10.	Grille for windows 12 kg/Sq.m	32.57	Sq. m	360.00	11725.20
11.	Doors	12.00	Sq. m	2780.00	33360.00
12.	Windows	17.58	Sq. m	2780.00	48872.40
		37.59 /Sq.m			117064.80
	Plastering and pointing				
13.	Plastering walls 1:4 12 mm	754.72	Sq. m	94.00	70943.68
14.	Plastering ceilings and Slabs CM 1:2	910.66	Sq. m	83.00	75584.78
		47.05 /Sq.m			146528.86
	Painting				
15.	Painting wood Enamel	80.84	Sq. m	65.00	5254.60
16.	Painting wood polish	80.84	Sq. m	28.00	2263.52
17.	Painting slabs and ceiling Distemper	1910.66	Sq. m	46.00	87890.36
18.	Painting wall exterior colour washing	570.38	Sq. m	12.00	684.56
19.	Painting wall interior Distemper	184.34	Sq. m	46.00	8479.64
20.	Painting wall interior white cement	184.34	Sq. m	31.00	5714.54
		37.39 /Sq.m			116447.22
	Electrical				
21.	Electrification L.S.		L.S.	10000	10000
		3.21 /Sq.m			10000
Total for ground floor		**370.64 / Sq.m**			**1154163.22**

Table 4.13 Cost Estimation for First floor by Estimator software

S.no	Description	Quantity	Unit	Rate	Amount
First Floor					
	PCC				
1.	PCC flooring 1:4:3	208.43	Cu. m	2736.00	570264.48
		183.13 /Sq.m		570264.48	
	RCC				
2.	RCC column Ready Mix	8.61	Cu. m	3828.00	32959.00
3.	RCC Beam Ready Mix	4.81	Cu. m	4050.00	19480.50
4.	RCC Steps Ready Mix	3.24	Cu. m	3000.00	9720.00
		19.96 /Sq.m			62159.58
	FORM WORKS				
5.	FORM WORKS RCC	1293.46	Sq. m	150.00	194769.00
		62.55 /Sq.m			194769.00
	Steel Requirements				
6.	Steel Requirements	6353.95	Kg	30.00	190618.50
		61.21 /Sq.m			190618.50
	Brick works				
7.	Brick works CM 1:6	72.81	Cu. m	2278.00	165861.18
		53.26 /Sq.m			165861.18
	Floor and wall finishes				
8.	Wall finishing marble tiles	8.10	Sq. m	500	4050.00
		1.3 /Sq.m			4050.00
	Doors and window				
9.	Frameswood	0.83	Cu. m	27840.00	23107.20
10.	Grille for windows 12 kg/Sq.m	32.57	Sq. m	360.00	11725.20
11.	Doors	12.00	Sq. m	2780.00	33360.00
12.	Windows	37.58	Sq. m	2780.00	104472.40
		55.45 /Sq.m			172664.80
	Plastering and pointing				
13.	Plastering walls 1:4 12 mm	754.72	Sq. m	94.00	70943.68
14.	Plastering ceilings and Slabs CM 1:2mm	1910.66	Sq. m	83.00	158584.78
		73.71 /Sq.m			229528.46

	Painting				
15.	Painting wood Enamel	80.84	Sq. m	65.00	5254.60
16.	Painting wood polish	80.84	Sq. m	28.00	2263.52
17.	Painting slabs and ceiling Distemper	1910.66	Sq. m	46.00	87890.36
18.	Painting wall exterior colour washing	570.38	Sq. m	12.00	684.56
19.	Painting wall interior Distemper	184.34	Sq. m	46.00	8479.64
20.	Painting wall interior white cement	184.34	Sq. m	31.00	5714.54
		37.39 /Sq.m			116447.22
	Electrical				
21.	Electrification L.S.		L.S.	10000	10000
		3.21 /Sq.m			10000
Total for First floor		**551.18 / Sq.m**			**1154163.22**

Table 4.14 Cost Estimation for Second floor by Estimator software

S.no	Description	Quantity	Unit	Rate	Amount
		Second Floor			
	PCC				
1.	PCC flooring 1:4:3	208.43	Cu. m	2736.00	570264.48
		183.13 /Sq.m			570264.48
	RCC				
2.	RCC column Ready Mix	8.61	Cu. m	3828.00	32959.00
3.	RCC Beam Ready Mix	4.81	Cu. m	4050.00	19480.50
4.	RCC Steps Ready Mix	3.24	Cu. m	3000.00	9720.00
		19.96 /Sq.m			62159.58
	FORM WORKS				
5.	FORM WORKS RCC	1293.46	Sq. m	150.00	194769.00
		62.55 /Sq.m			194769.00
	Steel Requirements				
6.	Steel Requirements	6353.95	Kg	30.00	190618.50
		61.21 /Sq.m			190618.50
	Brick works				
7.	Brick works CM 1:6	72.81	Cu. m	2278.00	165861.18
		53.26 /Sq.m			165861.18
	Floor and wall finishes				
8.	Wall finishing marble tiles	8.10	Sq. m	500	4050.00
		1.3 /Sq.m			4050.00
	Doors and window				
9.	Frames wood	0.83	Cu. m	27840.00	23107.20
10.	Grille for windows 12 kg/Sq.m	32.57	Sq. m	360.00	11725.20
11.	Doors	12.00	Sq. m	2780.00	33360.00
12.	Windows	37.58	Sq. m	2780.00	104472.40
		55.45 /Sq.m			172664.80
	Plastering and pointing				
13.	Plastering walls 1:4 12 mm	754.72	Sq. m	94.00	70943.68
14.	Plastering ceilings and Slabs CM 1:2mm	1910.66	Sq. m	83.00	158584.78
		73.71 /Sq.m			229528.46

Painting					
15.	Painting wood Enamel	80.84	Sq. m	65.00	5254.60
16.	Painting wood polish	80.84	Sq. m	28.00	2263.52
17.	Painting slabs and ceiling Distemper	1910.66	Sq. m	46.00	87890.36
18.	Painting wall exterior colour washing	570.38	Sq. m	12.00	684.56
19.	Painting wall interior Distemper	184.34	Sq. m	46.00	8479.64
20.	Painting wall interior white cement	184.34	Sq. m	31.00	5714.54
		37.39 /Sq.m			116447.22
Electrical					
21.	Electrification L.S.		L.S.	10000	10000
		3.21 /Sq.m			10000
Total for Third floor	**551.18 / Sq.m for 3114.00 Sq.m**				**1716363.22**
Total					**6303252.22**
Net amount					**6303253.00**

Table 4.15 Cost Estimation for Third floor by Estimator software

S.no	Description	Quantity	Unit	Rate	Amount
Third Floor					
PCC					
1.	PCC flooring 1:4:3	208.43	Cu. m	2763.00	570264.48
		183.13 /Sq.m			570264.48
RCC					
2.	RCC column Ready Mix	8.61	Cu. m	3828.00	32959.00
3.	RCC Beam Ready Mix	4.81	Cu. m	4050.00	19480.50
4.	RCC Steps Ready Mix	3.24	Cu. m	3000.00	9720.00
		19.96 /Sq.m			62159.58
FORM WORKS					
5.	FORM WORKS RCC	1293.46	Sq. m	150.00	194769.00
		62.55 /Sq.m			194769.00
Steel Requirements					
6.	Steel Requirements	6353.95	Kg	30.00	190618.50
		61.21 /Sq.m			190618.50
Brick works					
7.	Brick works CM 1:6	72.81	Cu. m	2278.00	165861.18
		53.26 /Sq.m			165861.18
Floor and wall finishes					
8.	Wall finishing marble tiles	8.10	Sq. m	500	4050.00
		1.3 /Sq.m			4050.00
Doors and window					
9.	Frames wood	0.83	Cu. m	27840.00	23107.20
10.	Grille for windows 12 kg/Sq.m	32.57	Sq. m	360.00	11725.20
11.	Doors	12.00	Sq. m	2780.00	33360.00
12.	Windows	37.58	Sq. m	2780.00	104472.40
		55.45 /Sq.m			172664.80
Plastering and pointing					
13.	Plastering walls 1:4 12 mm	754.72	Sq. m	94.00	70943.68
14.	Plastering ceilings and Slabs CM 1:2mm	1910.66	Sq. m	83.00	158584.78
		73.71 /Sq.m			229528.46

	Painting				
15.	Painting wood Enamel	80.84	Sq. m	65.00	5254.60
16.	Painting wood polish	80.84	Sq. m	28.00	2263.52
17.	Painting slabs and ceiling Distemper	1910.66	Sq. m	46.00	87890.36
18.	Painting wall exterior colour washing	570.38	Sq. m	12.00	684.56
19.	Painting wall interior Distemper	184.34	Sq. m	46.00	8479.64
20.	Painting wall interior white cement	184.34	Sq. m	31.00	5714.54
		37.39 /Sq.m			116447.22
	Electrical				
21.	Electrification L.S.		L.S.	10000	10000
		3.21 /Sq.m			10000
Total for Third floor		**551.18 / Sq.m**			**1154163.22**
Grand total				**6303253.00**	

Approximate Cost of Zero Energy Building (excluding foundation work)

The cost for ZEB is the approx. same as the normal structure the only difference is the addition of renewable energy sources and decrement of cost due to the replacement of concrete by green concrete. Here we consider only some renewable sources to convert normal building to zero energy building.

Assuming the same price in all four cities

- North INDIA (Kandaghat)

Cost of G+3 Building = 63 lacs (From estimator)

Electricity consumption from revit is approx. 17,000KWh.

As per MNRE 1 KW PV of solar panel produced 4 KWh units every day

1500 KWh of electricity a year

So we required 11 KW PV of solar panel in this building

Cost of solar panel 11KW PV = Rs. 4,95,000 (45/watt As per MNRE)

Reduction in cost due to use of Green concrete = Rs. 81,744 (approx)

Final cost of Zero Energy building in North India = 63 lacs.- 81,744 + 4.95 lacs.

= 67 lacs (approx)

Final cost of Normal building in North India = 63 Lacs. (approx.) as find out by estimator software

From this data we can say that Net Zero Energy building is approx.4 lacs. Costlier than the conventional building.

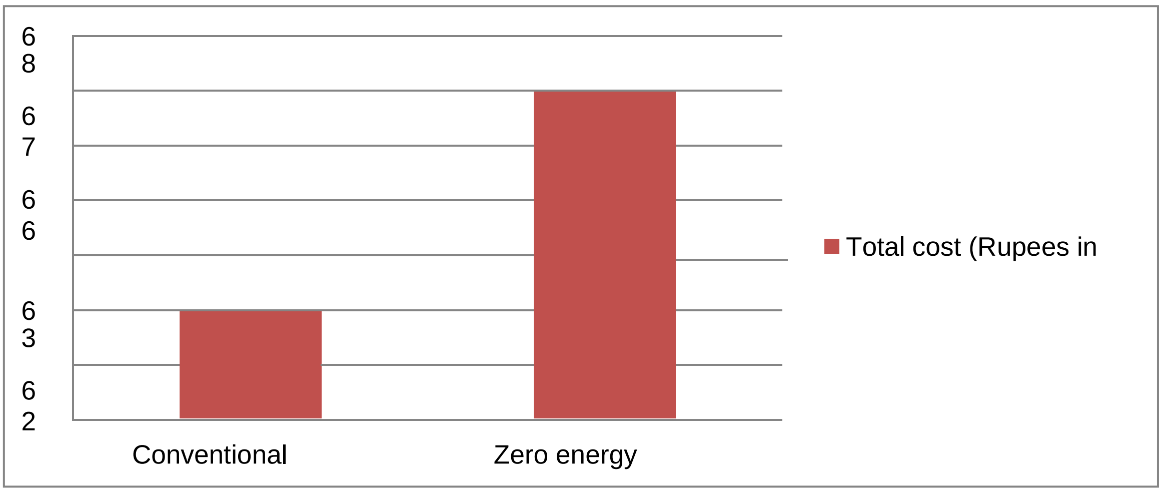


Fig.4.50 Comparison of Cost Estimation of zero energy and conventional building in Kandaghat

Assuming the same price in all four cities

- South INDIA (Kerala)

Cost of G+3 Building = 63 lacs (From estimator)

Electricity consumption from revit is approx. 19Kw

As per MNRE 1 KW PV of solar panel produced 4 KWh units every day

1500 KWh of electricity a year

So we required 13 KW PV of solar panel in this building

Cost of solar panel 13 KW PV = Rs.5,85,000 (45/watt)

Reduction in cost due to use of Green concrete = Rs. 81,744

Final cost of Zero Energy building in South India = 63 lacs.- 81,744 + 5.85 lacs.

= 68 lacs (approx)

Final cost of Normal building in South India = 63 Lacs. (approx.) as find out by estimator software

From this data we can say that Net Zero Energy building is approx. 5 lacs. Costly than conventional building.

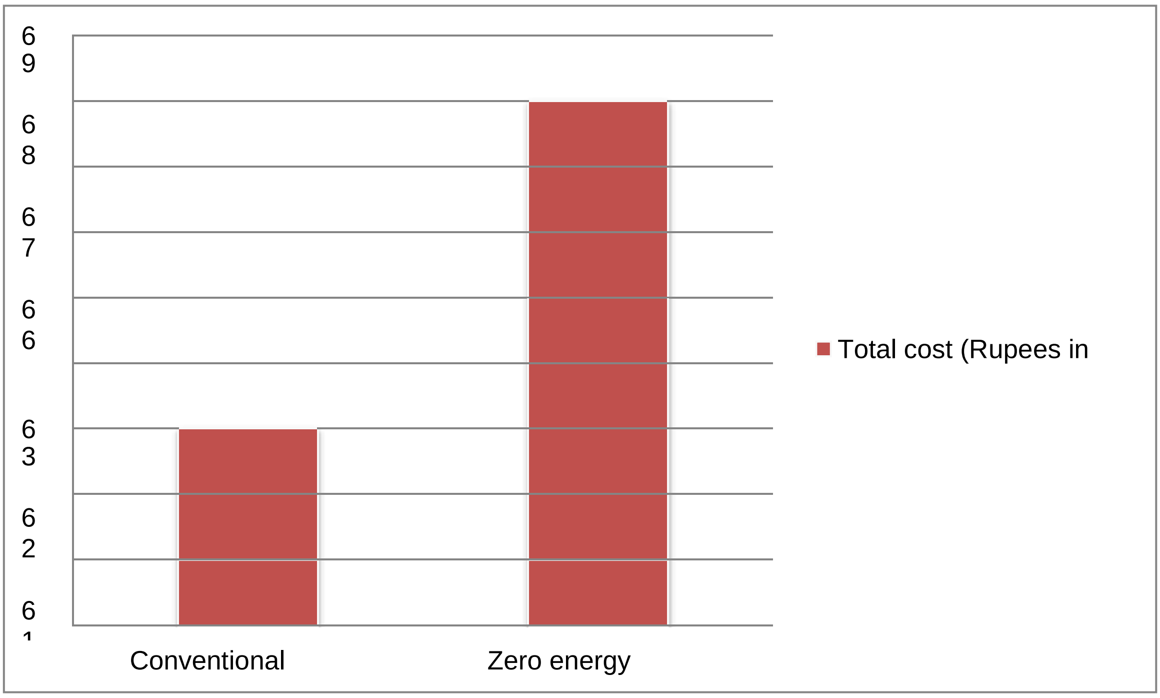


Fig.4.51 Comparison of Cost Estimation of zero energy and conventional building in Kerala

Assuming the same price in all four cities

- East INDIA (Darjeeling)

Cost of G+3 Building = 63 lacs (From estimator)

Electricity consumption from revit is approx. 21 Kw

As per MNRE 1 KW PV of solar panel produced 4 KWh units every day

1500 KWh of electricity a year

So we required 14 KW PV of solar panel in this building

Cost of solar panel 14 KW PV = Rs.6,30,000 (45/watt)

Reduction in cost due to the use of Green concrete = Rs. 81,744

Final cost of Zero Energy building in East India = 63 lacs.- 81,744 + 6.3 lacs. = 68.5lacs (approx)

Final cost of Normal building in East India = 63 Lacs. (approx.) as find out by estimator software

From this data we can say that Net Zero Energy building is approx. 5.5 lacs. costly than conventional building.

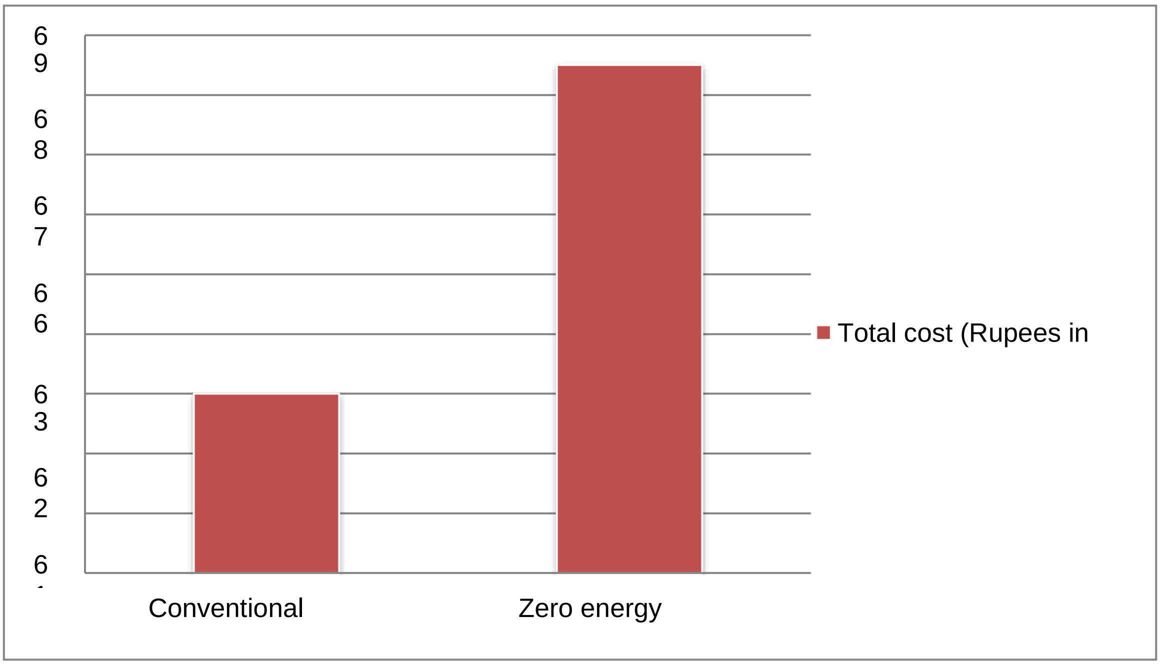


Fig.4.52 Comparison of Cost Estimation of zero energy and conventional building in Darjeeling

Assuming the same price in all four cities

- West INDIA (Ganganagar)

Cost of G+3 Building = 63 lacs (From estimator)

Electricity consumption from revit is approx. 22Kw

As per MNRE 1 KW PV of solar panel produced 4 KWh units every day

i.e. 1500 KWh of electricity a year

So we required 15 KW PV of solar panel in this building

Cost of solar panel 15 KW PV = Rs.6,70,000 (45/watt)

Reduction in cost due to the use of Green concrete = Rs. 81,744

Total cost of Zero Energy building in West India = 63 lacs.- 81,744 + 6.75 lacs. = 69 lacs (approx)

Final cost of Normal building in West India = 63 Lacs. (approx.) as find out by estimator software

From this data we can say that Net Zero Energy building is approx. 6 lacs. Costlier than the conventional building.

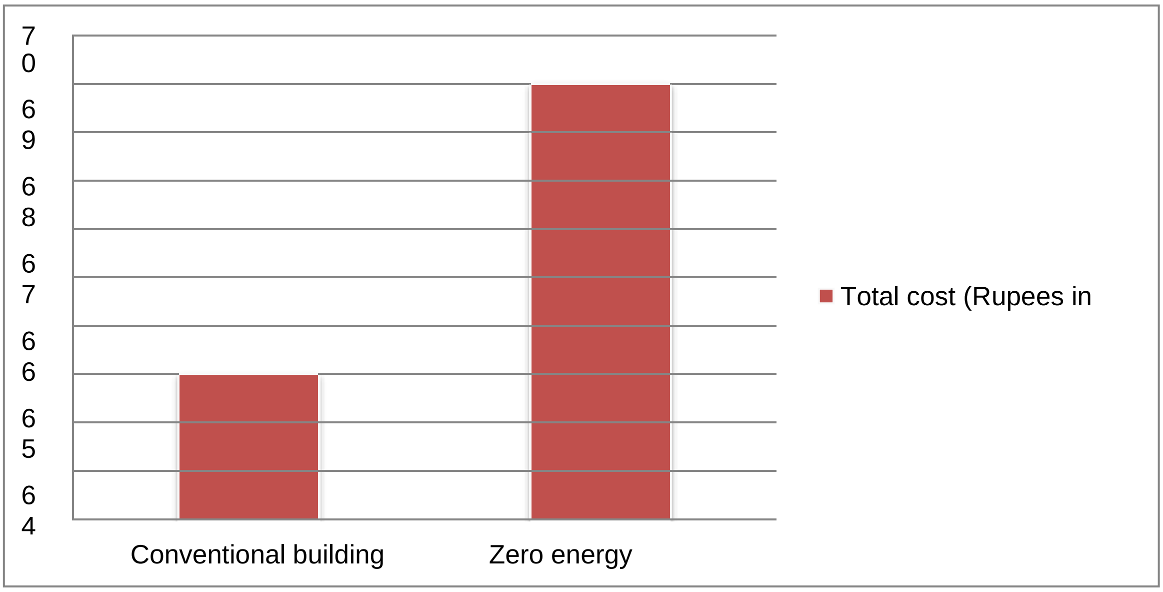


Fig.4.53 Comparison of Cost Estimation of zero energy and conventional building in Ganganagar

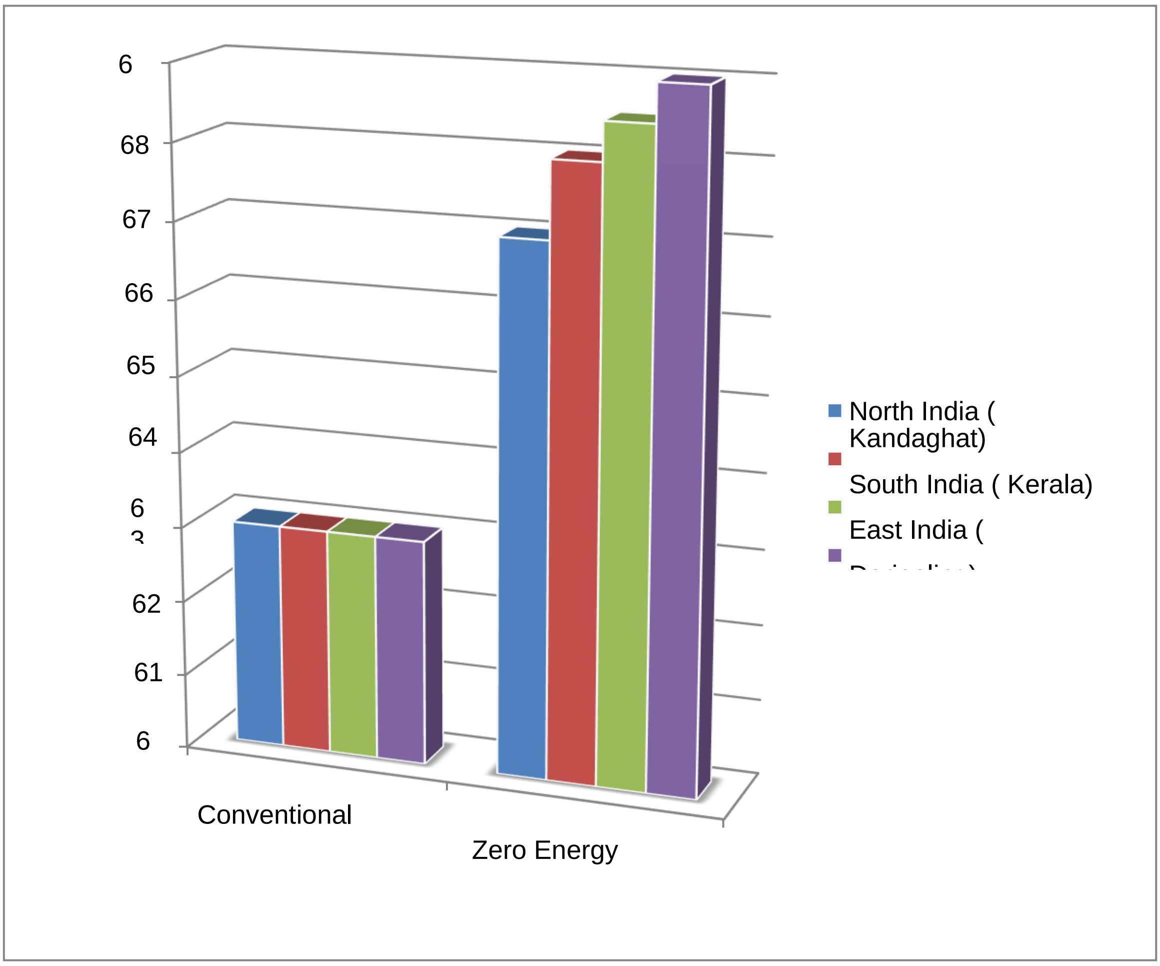


Fig.4.54 Final Comparison of Cost Estimation (in Lacs.) of zero energy and conventional building in all four regions of India

Finally, as per the calculation the energy used is found least in North India (Kandaghat). Also the Building made from Green concrete or (made from crumb rubber , waste crushed tiles and Bagasse) is found to be most economical in North India. As the cost of the Zero Energy Building are approx 5 to 7 lacs. more in all four regions of India. But This Cost can be compensated in 5 to 10 years with the Energy Consumption. This Building will be practically economical after some time and for very long duration

CHAPTER 6
DISCUSSIONS AND CONCLUSIONS

General

Using waste material in Concrete is a strategy for achieving two objectives: eliminating disposal problems of waste and adding some positive properties in concrete. Since the green concrete industry is increasing, it is important to evaluate concrete that contains waste from all viewpoints to decide its ability. This report shows the data and information about the usage of waste materials for the development of Structures. For making an economical situation it is essential to reuse the waste concrete and other waste material. Some of them are demolished concrete, gypsum, asphalt, wood, metals, plastics should be reused. It also helps in reduction of the landfill cost. If genuine measures is not taken at this moment, the accomolation of Construction waste products will overtake the value of approx. 290 million tonnes every year. Consequently, the current investigation is prescribed to use the waste materials in Concrete which will help to the earth, human wellbeing and development in construction field too.

Materials Identify

On addition of adding crumb rubber, bagasse and waste crushed tiles in concrete shows some positive results on the properties of concrete. As the speciific gravity of these wastes is in range of their respective replacement as concrete components so they can be added in the concrete. Also water absorption of these materials is in the range. So in my research I had optimized these waste materials in concrete by replacing them i.e. crumb rubber in place of fine aggregate, Waste tiles as the coarse aggregates, Bagasse as cement and then conduct a different test on concrete like compressive strength, tensile strength, etc. As per literature review the concrete properties expanded straight with replacement in mosaic tile total upto 30% substitution as coarse aggregates and after that decreased linearly, up to 2% replacement of crumb rubber as fine aggregate shows positive results, and replacing baggase as cement up to 50% also shows positive results. By optimizing all these waste the green concrete can be made with replacing 15% baggase as a cement replacement, 2% crumb rubber as replacement of sand, 15% waste tiles as replacement of coarse aggregates.

Conclusions

- Waste crushed tiles are replaced with coarse aggregates in design mix of M - 40 with an optimum percentage of 15%.
- Green concrete having strength almost same as conventional M – 40 concrete mix can be made with replacing 15% baggase as a cement replacement, 2% crumb rubber as replacement of sand, 15% waste tiles as replacement of coarse aggregates.
- G+3 floor building made from Green concrete is found to be stable in all locations (in Stadd. pro software)
- The difference between the conventional and Zero energy building is approx. 5 to 6 Lacs. This is expensive in the starting time but in context with long time this building can be found economical in respect to electricity bill, Environment pollution and many more. Hence it is a worthy investment.
- The motive behind green building and sustainable architecture is to utilize all the assets more proficiently and lessen the negative effect of building on the surface of earth.
- Zero energy buildings attain one objective of reduction in usage of energy and emission of different greenhouse gases.
- Taking everything into account, I concluded that for our Zero Energy House Project utilizing sunlight is going to be the best energy sources with respect to sparing vitality and cost-effectiveness.
- In this project it can be clearly seen from results that 32% of replacement gives the maximum strength and this replacement can saved an amount of up to Rs. 81,744.
- In last I concluded that if we used these waste materials in North India and East India and further we use renewable sources of energy for producing electricity, we can build an economic and stable building then other places of India. But in Darjeeling (East India) we have less economic building (than in Kandaghat (North India). Hence most stable and economic building is found to be in North India.

Future Scope

By replacing concrete components with waste materials up to some percentage we can make a concrete that is green and also helps in creating a sustainable environment. Also by using these wastes we can counter the problem of dumping of these waste materials. Also, these waste materials can be used to make:

- Lightweight concrete
- Leads to a sustainable environment
- low construction cost
- restrain micro-cracks
- restrain thermal change
- helps in waste management
- leads to sustainable construction
- natural resources can be saved
- reduces the landfill cost
- energy saving

By accounting these advantages one can carry forward this research as:

- Doing internal materials tests like XRD, Porosity, etc. to read the Chemical and Physical changes in green concrete as compared to Normal one.
- One can adopt some other waste materials and compare the cost reduction.
- One can use this waste material in heavy infrastructure like Bridges, Skyscrapers, etc. to find out the stability of this Green concrete.
- One can study the greenhouse gases Emission producing from this Green concrete.
- One can use Waste materials which have binding properties for making Green cement.

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