Innovative Sustainable Design and Techniques: A Review of Literature

Rajesh Kumar, Vanita Aggarwal, and S. M. Gupta

Abstract Imperishable development is the most trending issue all over the globe which is proposed to decrease the significant influence of the construction industry on the surroundings, society and economy. Several developed nations have embraced the Green Building Construction considering the most affirmative solution to the conservation of their natural resources, less consumption of energy and minimize the construction negative impacts on the climate and environment. A critical review of the literature has been conducted exploring the implementation of the Green Building Construction (GBC) in India which consists of relevant works of sustainability in construction materials, building rating tools and the comparative studies, with the goal to optimize design effort. This study also takes considerations of the green building evaluation tools for rating the performance of different buildings include Comprehensive Evaluation Procedure for Built Environment Efficiency (CASBEE), Green Building Tool (GBTool), Leadership in Energy and Environmental Development (LEED), GRIHA, Building Research Establishment Environmental Assessment Method (BREEAM). This rating will persuade the constructors to work more in the direction of constructing more efficient green buildings and convert the old building to a green building.

Keywords Sustainable design · Construction materials · Environmental assessment

R. Kumar (✉)
M.M. Engineering College, M.M. (Deemed to Be University), Mullana, Ambala 133207, Haryana, India
e-mail: Raj1rathee@gmail.com

V. Aggarwal
Civil Engineering Department, M.M. Engineering College, M.M. (Deemed to Be University), Mullana, Ambala 133207, Haryana, India

S. M. Gupta
Department of Civil Engineering, NIT Kurukshetra, Kurukshetra 136119, Haryana, India

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1 Introduction

A Sustainable/livable Building is a structure that is planned in such a manner to manufacture remodeled worked or reused in a biological and asset effective way. Green buildings are designed in such a way to connect determined objectives like saving occupant well-being; using water, energy and further more efficient resources and decreasing the influence on environment. Energy and substance depletion in buildings can put up noteworthy to worldwide change in weather conditions. The residential sector has the highest energy consumption amongst all sectors. Consequently, addressing energy efficiency in housing by providing comfortable environments that reduce the need for mechanical cooling and heating is essential. The cost of energy has risen as an outcome of the depletion of fossil fuel distribution in the whole globe. Due to this, nations around the globe have established sustainable plans between the formations of policy apparatus. Practically, all the fields including manufacturing, business, transportation, construction, have involved sustainable practices into their ongoing business plans to ensure surroundings safety [1]. According to the scientists and researchers, the way to diminish the hazards to the environment is to construct the structure imperishable and energy effective.

At design stage, the architect blueprint the structure through advanced software and techniques which evaluate, estimate and calculate the surroundings performance attributes of a building [2]. The environmental evaluation tools for buildings structure have been invented to furnish an objective assessment of quality of indoor environmental, assets use, and sustainable loadings, etc. [3]. These tools provides several methods to determine the criteria of sustainable buildings. The primary blueprint behind green building embraces efficient abate in consumption of energy, water and other resources, recycling of wastes and fortifying health of occupants. Green building uses alternate energy sources like solar energy that is renewal of electrical energy during daytime. Rain water harvesting systems are used in green building in such a way that water is efficiently reused before final disposal. A Green building is an energy efficient building which optimizes water use, and partially relies on natural sources of energy, generates less waste and provides a better indoor air quality for its occupants. It results in enhanced comfort level and productivity of its occupants.

2 Literature Survey

2.1 Sustainable Building Design: A Review

Wasilah et al. in 2019 studied the design process methods for green buildings and design with the principles of implementation in the structural design, the planning of the site and the natural energy for the conservation of the building's natural and thermal light. The study also explained that Matano Lake's potential views and sustainability are improved by the lake resort which is based on green buildings

and design with natural principles [4]. Hammond et al. in 2019 studies the gap between acceptance and slow adoption and implementation of the Green Building Agenda that has been studied. From an economic point of view we use game theory insights, especially the game model "StagHunt" as an explanation of the decision-making procedure for building buildings stakeholders in respect to understand how risks, cost, system of the market and by-laws can generate obstacles to the overall implementation and adoption of sustainable buildings. In addition, we look at how the asymmetry of awareness and information complicates such issues further. This model was concluded to be more effective [5].

Huang et al. in 2018 discussed the limits of existing building practices to the future energy conservation index for climate envelopes in Taiwan. Second, a new index, OTTV, is based entirely on the simulation results, and has attempted to convert existing baseline criteria for the new OTTV. Studies have shown that the OTTV equation has to change its coefficient over time due to warming climates, so that the changing climate reacts accurately. The analysis of this paper provides a way for the formulation of a climate-responsive index to pursue a future more energy-efficient building [5, 6].

Richard N. Lacroix et al. in 2007 overviewed the concept of "Green Building" or "Green Architecture". They examined the relative terms, the efficiency and the functionality of their application through references to international practices (Asia, Europe, and USA) and techniques of eminent green builders and green designers [7]. N. Huberman et al. in 2007 studied those existing structures are completely answerable for plentiful vitality utilization and resultant environmental emanations in numerous nations. Investigation into vitality effectiveness of structures has boss spotlight on the necessity of vitality for a structure's progressing utilization, even the vitality epitomized in its creation is regularly neglected. This type of perspective has initiated in last few years to strategies which strengthen the thermal performance of a structure yet which depends on high encapsulated vitality (EE) materials and items. Despite the fact that database and appraisal techniques have created in most recent couple of years, the genuine EE force for a given substance might be exceptionally reliant on neighborhood innovations and transportation separations. The primary motive is to distinguish building materials which may improve the vitality necessity of a structure over as long as it can remember cycle. It was discovered that the exemplified vitality of the structure represents some 60% of the general life-cycle vitality utilization [8].

Rebecca C. Retzlaff 2009 studied that this article was motivated to provide organizers with a preface to the idea of green structures and frameworks for building assessments and to identify and examine important themes in writing, as well as arrangements. Six subjects are recognized: scope, weighting, subjectiveness, precision, adaptation, and examination of the life cycle. Despite the fact that there is plenty of room for developing work in the field of green structure problems, organizers have started to create and actualize green structure arrangements and projects. The article ends with an expansive motivation of research, which can help to advance the exchange of work in the field of green structure issues. In order to add more weight to the problem, arrangements must progressively take place in green structures [9].

Kevern, J. T. 2011 discussed a system to consolidate the practical structure and think as another course of structural construction and meetings between the pilot's offers. Important territories are designed to help all designers understand maintenance in accordance with conventional building standards. In order to introduce ideas of structural support and basis support, introduction of green-building experts, green-building rating frameworks were used. Structural specialists can provide proactive solutions to a developing worldwide foundation by improving their understanding of support through training [10].

2.2 Innovative Sustainable Ratings

Sunita Bansal et al. in 2018 studied that green construction trends now give a lot of attention in the world today. In order to determine whether or not the specific building is green, the governing body develops many criteria for examining the growing practice of green building. The different criteria called the rating system are owned by each country, which is different according to the category, as in existing buildings and new buildings. The parameters of energy efficiency, materials, water efficiency, health etc. can be estimated. GRIHA and GBCI are essentially followed in India, ESGB in China and BREEAM in UK. In this paper, the various aspects of the existing green rating systems used in different countries were also overviewed [11]. Chandra Shekhar Singh et al. suggested in 2018 a green building concept involving a building designed, constructed, managed and maintained to improve the health of occupants, increase productivity, use natural resources wise and reduce the impact on the environment. This process focuses on the general environmental impact of the building including the design, construction, operation and maintenance phases, efficiency of development, resource efficiency, etc. The green buildings design should therefore start with the choice of environmentally friendly materials and the use of environmentally friendly materials. The fastest way to initiate the coordination of manageable plan ideas can be new application materials, reuse and, maintainable items and the careful selection of eco-logical feasible structural substances and the use of green assets. This paper emphasizes the contribution of sustainable construction materials to the production of healthy buildings that are environmentally sustainable. A small concept for saving the environment and saving energy: This paper presents GREEN CONSTRUCTION CONCEPT, a major step in eco-friendly energy and environment design in the building industry [9].

In 2015, Bhagyashri Kshirsagar et al. talked about the novelty and importance of the concept of sustainability in the construction sector worldwide. Today's market has innovative green building materials and technologies as green buildings are becoming increasingly aware. This paper examines the comparative analysis of BREEAM, LEED, Green Globes, IGBC and Eco Housing green building rating systems. The purpose of this paper is to propose amendments to Indian green building classification systems in the current scenarios in order to deliver the most efficient and healthy green construction [12]. Cesar A. Poveda et al. in 2014 explored the prospective

advantages of execution ERS in industries apart from the construction sector have been explored. The growing demand for the exploration and exploitation of natural resources has given greater attention both to the organization's impact and its stakeholders. It must be regulated with the intervention of government department and legal needs as single solution to diminish the negative influence. These procedures often give small practical help to companies in meeting triple end-point sustainability objectives while providing general guidance. More recently, a variety of tools have been developed to help businesses take decisions that best fit these objectives. This paper identifies potential benefits for industries to choose to use these tools to evaluate their sustainable performance [13].

Kushagra Varma et al. in 2014 proposed that buildings are one of the largest energy consumers and greenhouse gas producers. Buildings produce 35% of CO_2, 49% of SO_2, and 25% of NO found in the air, according to the NIBS (USA). In addition to thinking and implementing sustainable development in every new building, it has imposed immediate requirements. Green buildings agree to the principle of careful handling of the natural resources, which means that the use of surroundings friendly substances and the utilization of renewable energy assets cause as little environmental interference as possible. This paper concentrates on green design as a vital change in the architecture of contemporary development countries [6]. Farzad Jalaei et al. in 2014 studied that the building energy consumption is quite high as compared to normal; a major concern must thus be demonstrated with regard to sustainable construction projects and energy performance. Energetic analytical tools (EAT) have been used for years to design energy-efficient buildings. (BIM) Building Information Modeling has the potentiality to assist users evaluate different design substitutes, choose key energy strategies and systems at the imaginary design phase. With BIM tools, designers can choose the exact material type during the blueprint phase. A process that links EAT and BIM with a green building certification system is the principal goal of this study. It helps designers identify and measure potential energy losses or gains in various design substitutes and carried out possible LEED points, can pile up and get and choose the best one accordingly [13].

Peng Wu et al. in 2010 studied that the building sector is the greatest reason of greenhouse gas emissions in the world. One problem that is begging to be addressed originating from both interior and outer drivers for development and building organizations is being manageable or green. Several green rating systems have been developed to evaluate how sustainable or green the building is. This research focuses on comparing the Green Globes, LEED and the BCA Green Mark for comprehension present practices and addressing the importance of project management in sustainable and green construction. The discoveries recommend that the designing and development organizations take venture of the executives regarding both the training and the procedure into thought while satisfying the prerequisites of being green [7].

2.3 Green Building Challenge

Sabnis and Pranesh et al. in 2016 explained the impact of energy of generally adopted three formwork techniques in India and also briefed their inductions as far as collaboration esteems. They consider three diverse connection conditions I1, I2 and I3 as association between encapsulated vitality and materials and epitomized vitality. All around association was taken as logarithmic total of three affiliation. It was found that the total correspondence estimate for each square meter of the progress zone was based on ordinary formworks with steel floor plates, which differed from the estimated 31,781 and 30,490 domain improvements for coated systems with squeezed aluminum board and wood floor plates. In this respect, the supreme impact on the substance can be reduced by picking aluminum coating instead of customary coating by approximately 33% [14]. Joel Ann Todd et al. in 2015 stated that Green Building Challenge (GBC) was designed for the test, the improvement and the discussion of an assessment structure, criteria and instrument to push the flowering edge of the project execution examination. GBC was not designed for this application on particular commercial markets, contrary to other proprietary assessment systems. The job of GBC over the last five years was to give reference technology, structure and tools to promote new frameworks [12]. Tayyab Ahmad et al. declared in 2015 that the sustainable use of sustainable building systems and technology is subject to a sensible construction. Long-lasting economic benefits, health and environmental protection and designers need to optimize combinations of specific techniques and systems to provide user comfort. This research focuses on suggesting various approaches to implement multiple sustainable building technology systems and techniques into the blueprint process in order to optimize the aim of the design effort. Interviews of building practitioners and researchers who help to express design priorities focused on semi-arid climatic conditions. At the same time, a model is proposed that incorporates all three dimensions of sustainable development into building counterfeit programs, ease the implementation of green design [15].

Ahmed et al. in 2014 studied critical literary review in implementation of the GBC in Ghana was investigated. The study examined the current situation in Ghana and the drivers who are responsible for the current state. The implications of these drivers in the construction of Ghana are also discussed. The main step towards increased awareness and publicity campaigns, national education, the enforcement of binding public policies and regulations and financial incentives and market-based incentives, among others, should be taken to strengthen the concept in Ghana and Sub-Saharan Area (SSA) [16]. Niklaus Kohler et al. in 2014 explained the achievements and objectives of the international Green Building Challenge project that are analyzed. GBC is situated within the criteria of other international environmental methods. The differences between data problems outcome by these are discussed. The circumstance of a possible headway for widening GBC into Life Cycle Assessment philosophy, into different periods of life cycle and adjusting GBC for use with the current structure stocks are proposed. The ‘green’ structures idea is supplanted by a bigger idea of supportable improvement. The subject of how significant the GBC proposed targets

are in connection to the long-haul manageable improvement of structures stock, structures and urban situations is checked [17].

Huang et al. in 2013 assessed the environmental impact of China on the basis of material flow analysis, taking up to 2050, the consumption of the material in the construction industry. The results showed that natural extraction of materials and the effect of GHG in China will decrease in the years to come. They emphasized the reuse and recyclability of materials, in any case, to maintain practical progress. In the 2141 MJ/cum request, block stone work expends high rates of vitality among a few sub-systems comprised of a structural framework. SMBs use 715 MJ/cum compared to brick masonry. Around 38–45% of the brick block work vital is consumed by hollow concrete block. The most vital productive elective material in SMB manufacturing is closed [5]. Santamouris and Kolokotsa et al. discussed the application of passive cooling strategies in 2013, with the result that superior quality of indoor air and thermal solace with very low energy exhaustion significantly decreased their thermal impact. The three main methodologies for passive cooling are: the use of soil as a heat sink, evaporative cooling and, finally, the night cooling method. Passive strategies as an alternative to existing air conditioning at the building design stage are therefore of paramount importance [15].

2.4 Innovative Sustainable Materials

Sagheb et al. in 2011 studied that conventional material can be replaced by alternative materials with low incarnated energy in a building construction. Also admitted to the importance of low energy alternative materials. Based on their case study, they have found that a third decrease in carbon dioxide emissions is feasible by using low energy construction materials. The affordable housing policy and practice is important for energy conservation or usage of the recycling material. Constructing sustainable housing on a big quantum is the major challenge, committing a solution to the slum's density, unplanned increase, travelling congestion, and uncontrolled development of real estate. An academic view on policy for affordable housing and practiced that universally, affordable housing implementations are bifurcated into two wide strategic perspectives. Denmark, the Netherlands, Singapore and Sweden and other nations follow the global approach, where the whole population is furnished with decent and sustainable housing. On the other side, like the Canada, USA, and Malaysia, most of the European Unions, wherein poor sections aims, they would not get the same opportunities of the housing market.

Shahriar Shams et al. in 2011 declared that the building makes a large-scale contribution to greenhouse gas (GHG) emissions by emitting nearly 40% of carbon dioxide. Different types of construction materials emit CO_2 at different magnitudes. The choice of suitable building substances can considerably reduce CO_2 emissions and increase the sustainability and energy efficiency of our buildings. The research is a try to deal with the issues of imperishable construction of buildings and how building materials can be selected to reduce CO_2 emissions. In order to see CO_2

variation, a case study for a typical 90 m^2 home was analyzed. The case research showed that building substances like steel and aluminum should be encouraged less than glass and wood [18].

Sinem Korkmaz et al. in 2010 stated that green buildings of high performance require close building systems integration with an extraordinary spotlight on day lighting, vitality and material investigation during their plan forms. The present paper shows a case study of the Early Childhood Learning Centre's integrated design process carried out by a team of university students and faculty. During the blueprint development phases of the case research, the key decision on procedure modeling approach, necessary consultants, and virtual building prototypes was made. This case demonstrates that process modelling and visualization tools were used to give a precise information procedure for collective teams. From this experience, visualization tools and process modelling were seen as valuable components to accomplish superior structure objectives and diminish configuration process squander [1]. Daniel Castro-Lacouture et al. in 2008 explained that buildings cause a remarkable impact on the environment which is continuously increasing, firstly, due to the emission of major proportion of carbon and secondly, because of using a noteworthy number of energy resources. The development of green structure rose to limit these impacts and improved the structure development process. This effect ought to bring huge monetary, ecological, money related, and social advantages. So as to help the determination of the correct materials, the study proposes a multi-model number upgrade combining expenditure plans and structure limits while increasing the amount of loans provided to the rating system of LEED [19]. The renewable energy application for an existing building and reducing existing building energy depletion. To achieve this, two main perspectives are considered: One is to minimize the energy needs by implementing energy efficiency computations, and the other one is to offset the unused needs of building energy by optimizing renewable energy measures.

Huberman and Pearlmutter et al. in 2008 demonstrated that the use of life by the substances used in the designs of a casing absorb about half of the absolute vitality consumed by the structure and by the use of the elective low-exemplified building materials such as soil concrete squares, empty solid squares, fly debris blocks… The views correspond to studies conducted by [20, 21]. Thormark 2001, 2002 and Blengini 2009 note that the use of recycled materials can reduce energy consumption [22]. This is in line with Reddy and Jagdish's 2003 conclusions. In 2008, Dimoudi and Tompa added above to the situation by showing that 11 and 62% of steel and cement, about 8% of brick envelopes and about 4 per cent of aluminum composites contribute to GHG outflow. As detailed by Baird and Chan, Buchanan and Honey used vitality coefficients in the 1994 decision-making processes for all the carbon encapsulation. They have strongly suggested a move from solid steel and 45 aluminums to increased use of wood, which would cut CO_2 emissions significantly [20].

Reddy and Jagadish et al. In 2003 suggested alternative materials to enable reduction in the consumption of vitality saw that brick work comprises a significant segment in a structure development. In the Indian setting, they did ponder on five innovations of the building and looked at the utilization of vitality for each situation. They concluded that, stones use up least energy in the manufacturing process

however; some energy is used during transportation of stones to site. They also observed that Cement is also one of the high energy consuming construction materials with a minimum consumption of energy 5.85 MJ/kg [23]. Catarina Thormark et al. 2001 state that during the existence cycle of a structure, vitality utilization is a fast-developing examination field. In structures, where vitality is low, the epitomized vitality makes up a rising piece of the utilization of vitality. Reusing of materials likewise also gives the chances to reduce the encapsulated vitality by considering reusable recyclable materials parts and reused materials. This paper tells esteems on required vitality for any activity, encapsulated vitality, and the capability of reuse of the most vitality e1cient condo lodging in Sweden (45 kWh = m^2). In 50 years of life expectancy, epitomized vitality represented 45% of the complete vitality need. The reusing potential was somewhere in the range of 35 and 40% of the encapsulated vitality [24].

Shabha et al. in 1997 evaluated a maintenance cost relevant study in high-rise buildings situated in Birmingham [25]. The authors highlight a low-energy renovation scheme. The structure cost and sustainable cost aspect of high-rise structures were described in the research. They described that an approximate cost of building construction at the element stage can be create by taking into consideration the component cost and then evaluating how much of the component is needed to complete the building.

2.5 Innovative Value Engineering

Pratheeban et al. in 2020 studied sustainable and low budgeted housing value engineering in India [26]. As there is a shortfall of requirement-based, i.e., affordable housing due to fast track increasing population, the aim must be on value engineering to achieve the gap/shortfall of housing requirements. The researchers focused at considering the value engineering process for cost optimization, quality and time. Also, they focused at increasing the total project value. They resulted that alternating a material with same motives aids in minimizing the project cost, by adding its value. They evaluated that the study would highlight the benefits of value engineering in affordable and sustainable construction and the use of substitute substances to enhance the output and success of a project. They also establish that low budgeted housing has to be a decision for equalizing the requirements of the concerned people. PPP's motive is to aim on the housing shortfall problem for the low-income section. The policy requires an aggressive plan of action having capacity of changing the situations. PPP model, can resolve the smart housing shortfall problem in India at a certain level.

V. Aggarwal et al. studied the substantial solicitation of sustainable prefabricated pre-engineered wall technology for low budgeted and energy-efficient homes in India [27]. The team evaluated that affordable buildings in India have an essential increase in execution and blueprint aspect. It is proposed that the enhancement of the bio-based non-rural infrastructure is to adopt the climatic circumstances by using

sustainable substances in the construction. The sustainable substances including agro-industrial products, insulating substances, precast elements, prefab techniques, non-burnt bricks, and other materials. A simulation assessment was evaluated with respect to cost and energy analysis for 18 cases included in the research. As the results come out, the researchers endorse that the practicability for affordable large scale housing that is obtained for the dwelling units above 100, each considering 25 m^2 of area. This is because the single-unit construction is not viable, and prefab techniques of construction is more expensive in terms of all types of cost like erection cost, material cost, transportation cost.

The latest outlook on more imperishable and low-budgeted housing for lower-income segments in Turkey was taken in to consideration by researchers. As per the researchers, sustainability and affordability in the housing sector are the toughest concepts to conserve the environment universally and to avail social equity. It can be measured by optimization of life cycle measures. The cost analysis of the life cycle has been utilized in a sustainability concern for buildings. Construction industry used LCC to measure the number of entire buildings, their components and systems, substances costs and analyzing was ensued through the life cycle. Every sector of the society must be reached sustainably to conserve the surroundings completely.

3 Conclusion Summary

Energy usage, environment, mindful building design have become high priorities. The merits of green design are to provide buildings sustainable environment to society in general and building owners or users in particular. The development of such green buildings results in minimized devastation of natural habitats as well as bio-diversity, decreased air pollution and water pollution, lower water consumption, and enhanced user productivity. It is certainly relevant that all our future buildings should be designed to function as “Green buildings”. The necessity of these buildings is rising on a daily basis stimulating the need for novel and better ways of construction. This includes the use of new and sustainably improved materials of construction and application of new and developed techniques for construction.

References

1. Kibert CJ (2007) The next generation of sustainable construction. Build Res Inf 35(6):595–601
2. Morledge R, Jackson F (2001) Reducing environmental pollution caused by construction plant. Environ Manag Health 12(2):191–206
3. Cole RJ (2000) Editorial: cost and value in building green. Build Res Inf 28(5–6):304–309
4. Todd JA, Crawley D, Geissler S, Lindsey G (2001) Comparative assessment of environmental performance tools and the role of the green building challenge. Build Res Inf 29(5):324–335. https://doi.org/10.1080/09613210110064268

5. Thormark C (2002) A low energy building in a life cycle—its embodied energy, energy need for operation and recycling potential. Build Environ 37(4):429–435
6. Debnath A, Singh SV, Singh YP (1995) Comparative assessment of energy requirements for different types of residential buildings in India. Energy Build 23:141–146
7. Wu P, Low SP (2010) Project management and green buildings: lessons from the rating systems. J Prof Iss Eng Educ Pract 136(2), 64–70
8. Wasilah W, Hildayanti A, Hamzah H (2019) Green building with nature concept on lakeside resort design. Int J Environ Sci Sustain Dev 4(1):31–43
9. Retzlaff RC (2009) Green buildings and building assessment systems. J Plan Lit 24(1):3–21
10. Kevern JT (2011) Green building and sustainable infrastructure: sustainability education for civil engineers. J Prof Iss Eng Educ Pract 137:107–112
11. Bansal S, Grover T, Saini N, Sharma S. A review on existing green building rating system between different countries. Eng Technol. ISSN:0976-3104
12. Blengini GA (2009) Life cycle of buildings, demolition and recycling potential: a case study in Turin, Italy. Build Environ 44:319–330
13. Poveda CA, Young R (2015) Potential benefits of developing and implementing environmental and sustainability rating systems: making the case for the need of diversification. Int J Sustain Built Environ 4(1):1–11
14. Singh CS. Green construction: analysis on green and sustainable building techniques. ISSN:2575-8950
15. Ahmed T (2015) Selection of building technology based on sustainability requirements—Brazilian context. Archit Eng Des Manag 11(5):1–15
16. Ahmed K, Hatira L, Valva P (2014) How can the construction industry in Ghana become sustainable, pp 1–86
17. Buchanan AH, Honey BG (1994) Energy and carbon dioxide implications of building construction. Energy Build 20:205–217
18. Korkmaz S, Messner JI, Riley DR, Magent C (2010) High-performance green building design process modeling and integrated use of visualization tools. J Archit Eng 16(1):37–45
19. Castro-Lacouture D, Sefair JA, Florez L, Medaglia AL (2009) Optimization model for the selection of materials using a LEED-based green building rating system in Colombia. J Plan Lit 24(3–21)
20. Asif M, Muneer T, Kelley R (2007) Life cycle assessment: a case study of a dwelling home in Scotland. Build Environ 42:1391–1394
21. Chen TY, Burnett J, Chau CK (2001) Analysis of embodied energy use in the residential building of Hong Kong. Energy 26:323–340
22. Huberman N, Pearlmutter D (2008) A life-cycle energy analysis of building materials in the Negev desert. Energy Build 40:837–848. www.elsevier.com
23. Lacroix RN (2007) Green architecture and sustainable development: applications and perspectives, July 24–26
24. Dimoudi A, Tompa C (2008) Energy and environmental indicators related to construction of office buildings. Resour Conserv Recycl 53:86–95
25. Alkass S, Alhussein M, Moselhi O (1997) Computerized crane selection for construction projects. Assoc Res Constr Manag 2:427–436
26. Partheeban P, Dinakaran V, Raguraman D (2020) Powering sustainable development through the integration of teaching and research in engineering education. In: 6th International conference on advanced computing and communication system 2020. IEEE, Coimbatore
27. Aggarwal V, Gupta S, Sachdeva S (2012) Investigation on fly ash concrete for pavements. 3(3)
28. Hammond S (2019) Stakeholders embrace green construction as the right direction: but as individuals they make self-interested decisions. CIB World Building Congress
29. Tao H, Shi F, Tanikawa H, Fei J, Han J (2013) Materials demand and impact of buildings construction and demolition in China based on dynamic material flow analysis. Resour Conserv Recycl 72:91–101
30. Huberman N, Pearlmutter D (2008) A life-cycle energy analysis of building materials in the Negev desert. Energy Build 40:837–848

31. Reddy BVV, Jagadish KS (2003) Embodied energy of common and alternative building materials and technologies. Energy Build 35:129–137
32. Sabnis A, Pranesh MR (2016) Sustainability development index (SDI) for highrise buildings with concept of figure of merit. Int J Res Eng Technol 5(9)
33. Azadeh S, Vafaeihosseini E, Kumar P (2011) The role of building construction materials on global warming: lessons for architects. In: National conference on recent trends in civil mechanical engineering, CEEIT Hyderabad, India, March
34. Mattheos S, Kolokotsa D (2013) Passive cooling dissipation techniques for buildings and other structures: the state of the art. Energy Build 57:74–94
35. Shams S, Mahmud K, Al-Amin Md (2011) A comparative analysis of building materials for sustainable construction with emphasis on CO_2 reduction. Int J Environ Sustain Dev 10(4)
36. Jalaei F, Jrade A (2014) Integrating building information modeling (BIM) and energy analysis tools with green building certification system to conceptually design sustainable buildings. J Inf Technol Constr (ITcon) 19:494–519
37. Shams S, Mahmud K, Al-Amin M (2011) A comparative analysis of building materials for sustainable construction with emphasis on CO_2 reduction. Int J Environ Sustain Dev 10(4):364–374
38. Thormark C (2006) The effect of material choice on the total energy need and recycling potential of a building. Build Environ 41(8):1019–1026
39. Kohler N (1999) The relevance of green building challenge: an observer's perspective. Build Res Inf 27(4/5):309–320
40. Varma K, Chaurasia M (2014) Green building architecture: a literature review on designing techniques. 4(2):1. ISSN:2250-3153
41. Kshirsagar B, Mane V. Comparative analysis of green building rating systems. 3(2). ISSN:2349-4476