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RESEARCH ARTICLE

GREEN BUILDING-ERGONOMICS & WORKPLACE ENGINEERING.

Megha and Jitendra Kogta.
Department of Fashion Technology, National Institute of Fashion Technology, Bengaluru.

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Abstract

Green building is one of measures been put forward to mitigate significant impacts of the buildings on the environment, society and economy. However, there is lack of a systematic review of this large number of studies that is critical for the garment industry in particular .This paper specifically focuses on the garment sector and derive various technologies that can be adopted in garment industry.This paper reports a critical review of the existing body of knowledge of research related to green building. It also compares the various certification authorities for Green Buildings which are recognised all over the world. Moreover, the paper also discusses various technologies that can be adopted for making a building. These technologies can be easily adopted by the garment industry that will eventually help the Garment sector to increase production, efficiency etc. by simultaneously reducing the effect of the garment factories on the surroundings.

Introduction:-

Green Building

"Green" or "sustainable" buildings use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code. With more natural light and better air quality, green buildings typically contribute to improved employee and student health, comfort, and productivity [1]. Green Building is defined as a "building that includes design, development and operational practices that essentially decrease or remove negative effects of growth on the environment and people. Green structures are energy effective, asset, productive and environmentally responsible.

With the rapid development of the economy and society, the shortage of energy and the Deterioration of environment has become two major problems faced by human beings in today's society. At present, the building industry is the leading source of consumption of world energy sources and various kinds of resources like ores, wood, and so on, as well as the major source of environmental pollution. According to the United Nations Environment Programme (UNEP), energy consumption in the building industry accounts for about 30–40% of the world's energy consumption. China's energy consumption is among the highest in the whole world, and the consumption of the building industry accounts for 38% of the total social energy consumption faced with a grim situation, the transformation and upgrading of the building industry is imminent. However, it is dicot for the industry to figure out a green, environmentally friendly, and sustainable road for development. Therefore, there is an urgent need for exploring and establishing the sustainable development mode of the building industry in order to transform the current situation of high resource consumption and high environmental pollution. The report of Our Common

Corresponding Author:-Megha.
Address:-Department of Fashion Technology, National Institute of Fashion Technology, Bengaluru.

Future, issued by the World Commission on Environment and Development (WCED) in 1987, formally put forward sustainable development strategies. The United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, proposed the Rio Declaration on Environment and Development and, Agenda 21. The agenda provides a separate section on promoting sustainable human settlement development, focusing on improving settlement planning and management, providing integrated environmental infrastructure, and achieving sustainable settlement development for energy and transport systems. This is the embodiment of the concept of sustainable development in the field of buildings, as well as the concrete realization of green building [2].

Literature Review

There is a growing awareness of the need to conserve energy due to general concerns about climate change, dependence on foreign oil, and the prospect of rising energy costs. As a result, a great deal of interest in energy efficiency and social consciousness has been evidenced, as indicated by an ever-increasing number of energy-efficient buildings being constructed in the United States and most other developed nations [3]. In fact, there are many energy efficiency, water conservation, and environmental protection efforts that are currently underway. Examples of these endeavors can be found all around the planet and include the achievement of better automobile manufacturing with increased mileage, higher use of mass transit, increased weatherization of residential units, and improvement in air quality, to name a few. The use of green building technology is another example of these efforts. With buildings estimated to account for approximately half of all annual energy and greenhouse gas emissions, a contributing solution to the nation's environmental and energy concerns is to ensure that the design, construction, operation, and maintenance of buildings are environmentally sustainable [4].

What is green building?

A 'green' building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts on our climate and natural environment. Green buildings preserve precious natural resources and improve our quality of life.

There are a number of features which can make a building 'green'. These include:

1. Efficient use of energy, water and other resources
2. Use of renewable energy, such as solar energy
3. Pollution and waste reduction measures, and the enabling of re-use and recycling
4. Good indoor environmental air quality
5. Use of materials that are non-toxic, ethical and sustainable
6. Consideration of the environment in design, construction and operation
7. Consideration of the quality of life of occupants in design, construction and operation
8. A design that enables adaptation to a changing environment

Any building can be a green building, whether it's a home, an office, a school, a hospital, a community centre, or any other type of structure, provided it includes features listed above. However, it is worth noting that not all green buildings are – and need to be - the same. Different countries and regions have a variety of characteristics such as distinctive climatic conditions, unique cultures and traditions, diverse building types and ages, or wide-ranging environmental, economic and social priorities – all of which shape their approach to green building.

Harmful Effects of Buildings

Environmentally harmful activities differ from one industry to another, but it is well known that the biggest contributor to GHG emissions is the built environment, accounting for up to 50% of global carbon dioxide emissions. In addition, the embodied environmental impacts generated by the building during its whole life-cycle, can be of the same order of magnitude as those generated during the utilisation stage. The building construction industry consumes 40% of the materials entering the global economy and generates 40–50% of the global output of GHG emissions and the agents of acid rain.

The construction sector is responsible for a high percentage of the environmental impacts produced by the developed countries. In the European Union, the construction and building sector is responsible for roughly 40% of the overall environmental burden. Homes in the UK (their construction and occupation) are responsible for the consumption of 40% of primary energy in the country. If the other 30% of the building stock (non-residential) is considered, the impact of buildings is greater. The construction industry is a highly active sector all over the world, and it is the largest industrial employer, accounting for 7% of total employment, and 28% of industrial employment. It is responsible for a high rate of energy consumption, environmental impact and resource depletion. Most

European governments have introduced new policy instruments such as the European Community's energy performance directive for buildings (EPBD) in order to reduce the negative impacts from the building sector.

Benefits of Green Building

The world over, evidence is growing that green buildings bring multiple benefits.They provide some of the most effective means to achieving a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth.

The benefits of green buildings can be grouped within three categories: environmental, economic and social which are discussed below:-

Environmental

One of the most important types of benefit green buildings offer is to our climate and the natural environment. Green buildings can not only reduce or eliminate negative impacts on the environment, by using less water, energy or natural resources, but they can - in many cases - have a positive impact on the environment (at the building or city scales) by generating their own energy or increasing biodiversity.

Economic

Green buildings offer a number of economic or financial benefits, which are relevant to a range of different people or groups of people. These include cost savings on utility bills for tenants or households (through energy and water efficiency); lower construction costs and higher property value for building developers; increased occupancy rates or operating costs for building owners; and job creation.

Social

Green building benefits go beyond economics and the environment, and have been shown to bring positive social impacts too. Many of these benefits are around the health and wellbeing of people who work in green offices or live in green homes due to well-ventilated offices as well as better indoor quality levels.[5]

Basic Elements for Green Building

A green building has four main elements or components on which it is designed: materials, energy, water and health to make green building more sustainable. The elements can be included from the construction stage or alternatively can go for Green Building certification by authorised party by fulfilling all the prerequisites needed for the certification. Following are some of the basic elements of a Green Building:

Materials for Green Building

Materials for a green building can be obtained from natural, renewable sources that have been managed and harvested in a sustainable way; or they are obtained locally to reduce the embedded energy costs of transportation; or salvaged from reclaimed materials at nearby sites.Materials are assessed using green specifications that look at their Life Cycle Analysis(LCA) in terms of their embodied energy, durability, recycled content, waste minimisation, and their ability to be reused or recycled. Examples are Bamboo, Cork flooring etc.

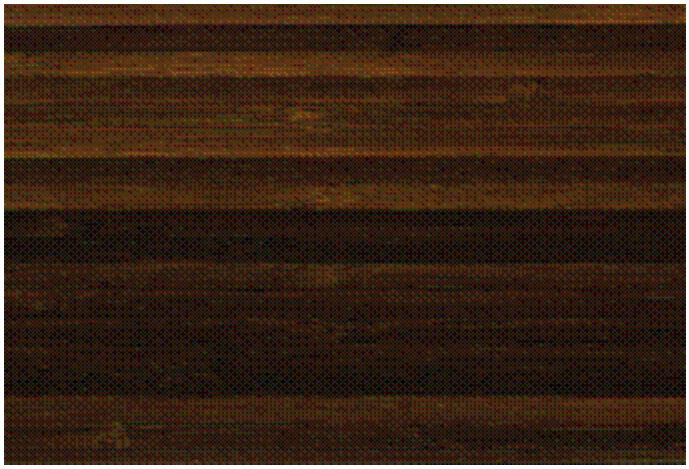

Figure 3.1:-Chocolate Bamboo

Energy Systems in Green Buildings

Passive designs that take advantage of natural environment will dramatically reduce the heating and cooling costs of a building, as will high levels of insulation and energy-efficient windows. Natural daylight design reduces a building's electricity needs, and improves people's health and productivity. Green buildings also incorporate energy-efficient lighting, low energy appliances, and renewable energy technologies such as wind turbines and solar panels.

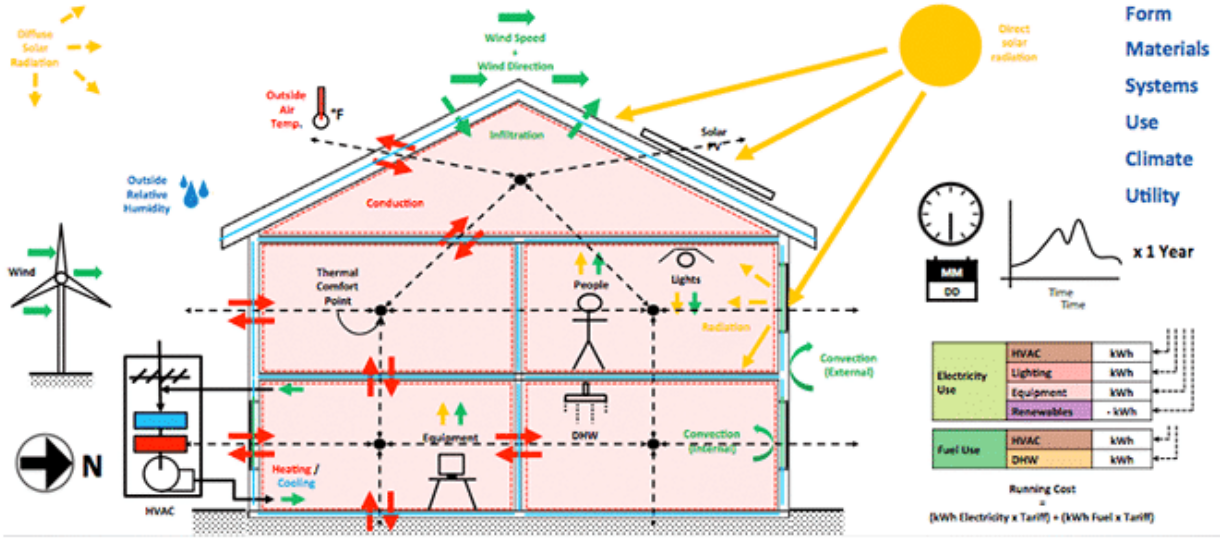

Figure 3.2:-Utilisation of renewable resources for Green Building

Water Management in Green Building

Minimising water usage can be achieved by installing greywater and rainwater catchment systems that recycle water for irrigation or toilet flushing; water-efficient appliances, such as low flow showerheads, self-closing or spray taps; low-flush toilets, or waterless composting toilets. Installing point of use hot water systems and lagging pipes saves on water heating.

Health components of Green building

Using non-toxic materials and products will improve indoor air quality, and reduce the rate of asthma, allergy and sick building syndrome. These materials are emission-free, have low or no VOC content, and are moisture resistant to deter moulds, spores and other microbes.

Indoor air quality is also addressed through ventilation systems, green plants and materials that control humidity and allow a building to breathe.[6]

Assessment Tools and Bodies

A number of assessment systems have been built to assist the green building developments.The leading green building assessment tools include:

1. Leadership in Energy and Environmental Design (LEED,UnitedStates)
2. BREEnvironmentalAssessmentMethod(BREEAM,UnitedKingdom)
3. Green Building Council of Australia GreenStar(GBCA,Australia)
4. BCA(Building and Construction Authority) Green Mark Scheme(Singapore)
5. Comprehensive Assessment System for Built Environment Efficiency(CASBEE,Japan)
6. Pearl Rating System for Estidama(AbuDhabi Urban Planning Council)
7. HongKong Building Environmental Assessment Method(HKBEAM)
8. Green Building Index(Malaysia)

All these green building assessment tools are voluntary rather than mandatory.It was developed by the green building council in each country/region.The assessment is undertaken by accredited professionals that are commissioned by the green building council.The World Green Building Council has been established to coordinate the efforts of various green building councils over the world.The structures of these green building assessment tools

are similar to a large extent,e.g.covering various aspects of sustain-ability, a number of credits available under each category, different rating tools for various types of projects.For instance,the Green Building Council Australia (GBCA) released eight rating tools(i.e. Education, Office, Industrial, Education, Healthcare, Office Interiors, Retail Centre, Public Building, and Multi Unit Residential) with two other pilot tools(Communities, and Interiors).There are nine categories of the GBCA Green Star rating tools,i.e.management, indoor environmental quality, energy, transport, water, material, land use and ecology, emissions, and innovation.Under each category, a certain number of credits(each with some points) are available to apply.The total number of weighted points is105, including 5points for the Innovation category.According to the total points achieved, GBCA certified three levels of Green Star buildings, i.e. 4 Star (achieving 45–59 points,labeled as Best Practice); 5 Star(achieving 60–74, labeled as Australian Excellence); and 6 Star(achieving more than 75 points,labeled as World Leader).Office buildings shared the biggest proportion of GBCA Green Star market, accounting for 60% of the total number of green buildings certified by GBCA.In addition,GBCA certified education buildings achieved rapid growth in last 2–3 years. It is worth noting that green buildings in different countries are designed and built according to local climatic conditions and to suit the requirements of the locals.Therefore,the assessment criteria for these green building are different.This is reflected in the fact that the points allocated for water efficiency are different in LEED and GBCA rating tools.For example,landscape water efficiency accounts for 8.3% of total points available for water category in GBCA Green Star Office V3 tool whereas for as high as 40% in LEED New Construction and Major Renovation tool. There is even the case in different states of Australia when applying the same GBCA rating tool.For instance, Water category receives a weighting of as low as10% in Northern Territory and Queensland; and as high as15% in South Australia, Tasmania and Victoria in GBCA Green Star Health care V1 tool.This is arguably due to the more significant issue associated with water resources in these three states. There are also extensive studies focusing on developing new green building rating tools(or customizing existing tools)to accommodate specific local context such as climatic conditions,economic development level and geographic conditions[7].

Certification Comparison

A lot of certification bodies are available that works towards assessing green buildings. Some works with the standards developed by third-party or some are independent bodies that releases their own certificates which are recognised globally. The Certification bodies will evaluate a building and provides ratings on the basis of the standards as well as the Rating System followed by the Certification authorities.The rating will be done for the documents and reports submitted during the application stage. And hence, it is very important to study and compare the certification provided by the assessment bodies.The table below shows some of the differences associated with the certifications: [8, 9, 10, 11]

S.No.	Description	LEED	BREEAM	GBCA	PEARL RATING SYSTEM
1	Stands for	Leadership in Energy and Environmental Design (LEED)	BREEnvironmentalAssessmentMethod(BREEAM)	Green Building Council of Australia GreenStar(GBCA)	Pearl Rating System for Estidama
2	Country	United States	UnitedKingdom	Australia	Abu Dhabi
3	Certification	LEED certification	3rd party certification	Green star certification	
4	Standards	Working on LEED standards	Works on the Standards developed by BRE	Working on Green Star standards	
5	Categories	LEED Rating categories include:Innovation and Design Process, Energy and Atmosphere, Water efficiency, Sustainable sites, Materials and resources, Indoor environmental quality	Measures sustainable value in a series of categories like: Energy, Health and well being, Innovation, Land Use, Materials,Management, Pollution, Transport, Waste, Water	Green start categories:Management, Indoor Environment Quality, Energy, Transport, Water, materials, Land use and ecology, Emissions and Innovation	Integrated Development Process, Natural Systems, Liveable Spaces, Precious water, Resourceful Energy, Stewarding materials, Innovating practices.
6	Qualification criteria	Project must meet all the prerequisite requirements		Registeration via online process at www.gbca.org.au	
7	Prerequisites	Erosion & Sedimentation Control, Fundamental Cx, Minimum Energy performance, CFC reduction, Storage and collection of recyclables, Minimum IAQ performance, Environmental Tobacco Smoke Control			*Pearl Rated::all required credit requirements must be met, *Green Pearl Rated::all required credit requirements must be met with a minimum of 50%optional credits *Exemplar Pearl Rated::all required credit requirements must be met with a minimum of 75%optional credits
8	Total points	69		1-6stars	3levels: Pearl Rated, Green Pearl Rated, Exemplar Pearl Rated
9	Tools	LEED Tools: Letter Templates, Calculators, Scorecard, USGBC website		Green star rating tools include:Design and as Built,Interiors, Communities, Performance	

Table 5.1:-Comparative study of Certifications Available for Green Building

Latest Technology Adopted for Green Building

A Green Building is usually made up of reusable materials and other materials which make the building efficient and environment friendly. It usually took advantage of the natural renewable resources so that they can be utilised to their maximum potential.And green buildings cover everything from geothermal heating to energy-efficient appliances.

Natural resources which are present in abundance can be utilised in an effective way to cut down the energy consumption.These technologies are being actively used throughout the world and slowly countries are trying to reduce their impact on the environment by adopting such technologies for the buildings. Discussed below are a few of the technologies being used to build sustainable building structures:

The Sunflower Home Heliostat

The Sunflower Heliostat harnesses the sun's energy with the help of regular glass mirrors which are 95% efficient at reflecting both heat and light.These are compact enough to be used at homes to brighten up the dark rooms or shade-filled spots in the gardens.The Sunflower is very powerful and can generate up to 500 watts of power in the form of light and heat[12].

Figure 6.1:-The Sunflower Home Heliostat

Beyond Windows: Light collection, transport and distribution

Buildings with large interior spaces or limited access to sunlight can use collection systems to harvest natural light, and other systems to transport or concentrate that light into specific areas.One intriguing example of such an integrated solution, combining daylighting and solar art, was designed by Peter Erskine for a municipal facility in California (see "Daylighting meets art" below)

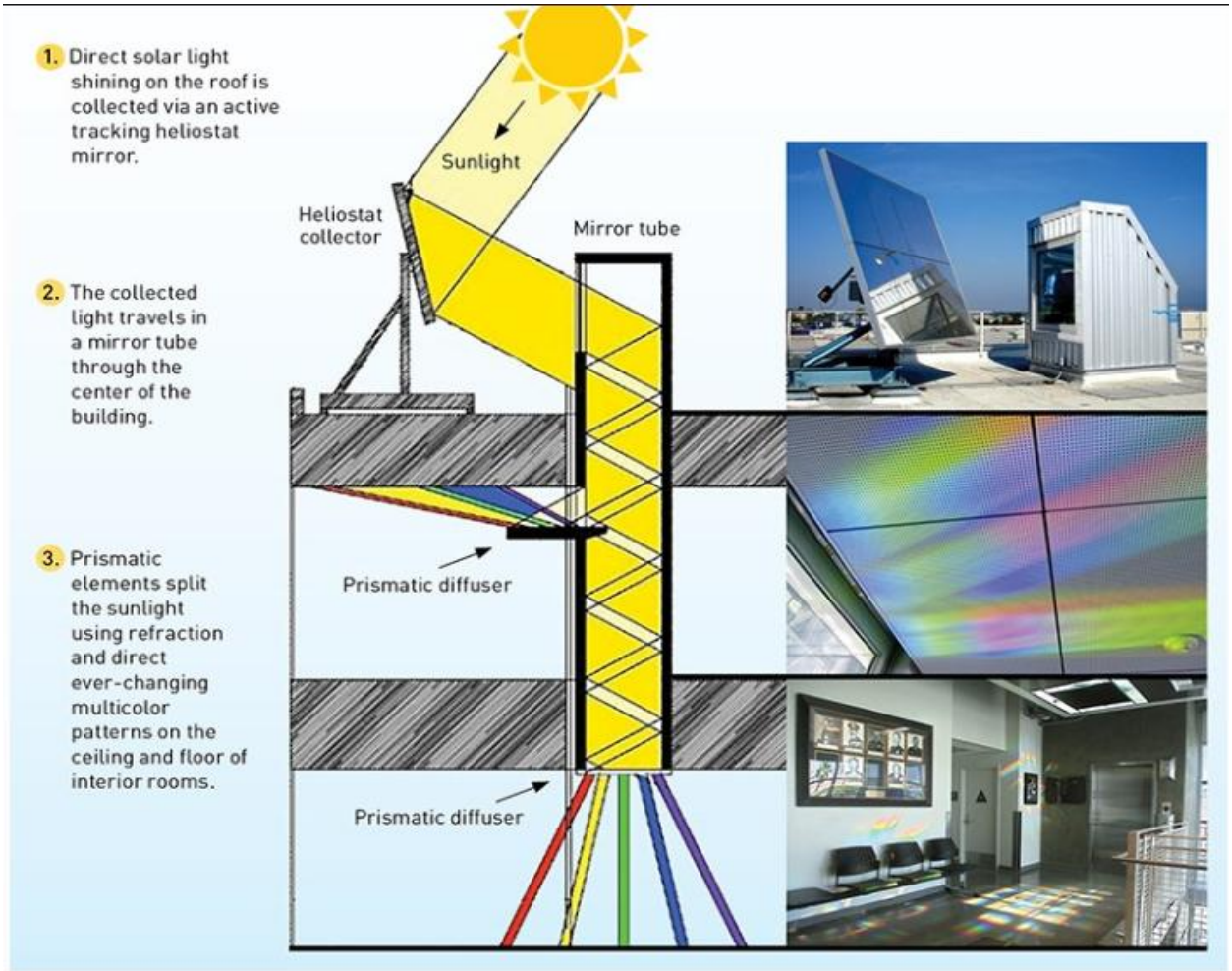

Figure 6.2:-Daylighting meets art: Erskine solar project

The Solar Spectrum Environmental Artist Peter Erskine created a daylighting system for the Los Angeles Police Department, Valley Traffic Division, Calif., USA that marries shrewd light guiding with an aesthetic approach to interior light. [Artwork and photography copyright by Peter Erskine, www.erskinesolarart.net] [13]

Green Roofs

A green roof or living roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Container gardens on roofs, where plants are maintained in pots, are not generally considered to be true green roofs, although this is debated. Rooftop ponds are another form of green roofs which are used to treat grey water. The term green roof may also be used to indicate roofs that use some form of green technology, such as a cool roof, a roof with solar thermal collectors or photovoltaic panels. Green roofs are also referred to as eco-roofs, oikosteges, vegetated roofs, living roofs, Green roofs and VCWH (Horizontal Vegetated Complex Walls).

Benefits

1. Reduced heating due to fewer fluctuations in roof temperature and insulating properties of vegetation
2. Reduced cooling costs due to fewer fluctuations in roof temperature and heat loss due to evaporation in the summer
3. Increased property value
4. Extension of the life of the roof membrane because of protection from intense ultraviolet radiation and continued expansion and contraction due to fluctuating temperatures
5. Noise insulation

Rammed Earth Brick

Rammed Earth is an ancient construction technique similar to adobe that uses the raw materials of the Earth to form sturdy Buildings through a simple process. Rammed earth has been around for thousands of years -- portions of the Great Wall of China were constructed using the rammed-earth technique. Today, the process of forming a rammed-earth structure isn't so different than it was centuries ago. A moist mixture of earth and hard substances such as lay or gravel are combined with a stabilizing element like concrete and compressed to form dense, hard walls. After forming, rammed earth must cure for months -- or as long as two years -- in a humid climate to fully cure and completely harden. The density of rammed earth makes it an ideal material for regulating the temperature of a building. It will stay cool in the summer and warm in the winter, and constructing rammed earth produces fewer emissions than the typical building process. Modern rammed-earth equipment makes the compacting process a bit easier than it was thousands of years ago, but there are still tools out there specially designed to compress the walls by hand.

Earth-sheltered buildings

During the summer, soil temperatures at certain depths are considerably lower than ambient air temperature, thus providing an important source for dissipation of a building's excess heat. Conduction or convection can achieve heat dissipation to the ground. Earth sheltering achieves cooling by conduction where part of the building envelope is in direct contact with the soil. Totally underground buildings offer many additional advantages including protection from noise, dust, radiation and storms, limited air infiltration and potentially safety from fires. They provide benefits under both cooling and heating conditions, however the potential for large scale application of the technology are limited; high cost and poor day-lighting conditions being frequent problems. On the other hand, building in partial contact with earth offer interesting cooling possibilities. Sod roofs can considerably reduce heat gain from the roof. Earth berming can considerably reduce solar heat gain and also increase heat loss to the surrounding soil, resulting in an increase in comfort [14].

Conclusion:-

This study reported a critical review of the existing studies related to Green Buildings worldwide.The extensive Literature review shows that most of the Green building studies focus on environment aspects of sustainability such as water efficiency, low energy consumption, as well as reducing the carbon footprint. The study not only considers the positive aspects but also the harmful effects that the buildings have on the environment which ultimately deteriorates the health of the operators who are working in the garment sector. This impact can lead to low productivity as well as efficiency. And hence, companies should adopt various practices as well as technologies mentioned in the paper so as to reduce its impact on the environment.

Also, it is worth noting that all leading green building assessment tools such as LEED, BREEAM and GBCA Green Star are designed according to local climatic and geographic conditions.The benchmarking study needs to be taken into consideration and can be taken up for further investigations in future research.

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