

Global Climate Crisis and the Measures Taken Against the Accelerating Deterioration of the Earth - Sustainable Measures in Architectures Future

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Abstract: The global climate crisis is a real threat to future generations on Earth. The effects of climate change first started showing up during the industrial revolution. Especially in London where water from the River Thames became non-drinkable and the air became impossible to breathe in. This research specifically focuses on the global climate crisis and the measures taken against the accelerating deterioration of the earth. We also look into which factors play a major role in accelerating the process. We researched the current deteriorating climatic conditions that started first from the industrial revolution and the discovery of plastic has only accelerated its effects. The main focus is on how the architecture and building construction industry has been a part of worsening the situation on our planet and in which direction of decelerating the process are we going. It also includes sustainable methods to mitigate the detrimental impacts that it has caused throughout the years since the modern architectural revolution. These measures are discussed in detail for the future of architecture, in particular materials and urban life. Moreover, we can say that passive technology is as important as AI. Research for new, durable materials must continue so that they can be mass-produced without causing serious damage to our environment.

Keywords: Global Climate Crisis, Urban Life, Architecture

1. Global Climate Crisis

The global climate crisis is a real threat to future generations on Earth. The effects of climate change first started showing up during the industrial revolution. Especially in London where water from the River Thames became non-drinkable and the air became impossible to breathe in. [1] These were the starting point but the next big stage was the discovery of oil and the boom in the economy. This led to many significant inventions for modern-day life. But today, we can see the correlation between the depletion of oil resources and the surges in greenhouse gas emissions around the globe.

Currently, 6 billion out of 8 billion people depend on fossil fuel energy, that is, coal, gas, oil etc. [2] Since most of the world's energy resources are based on fossil fuels that have a bigger impact on the world. There have been more forest fires in the last 10 years than in the recorded history of mankind

because of rising temperatures, wind and low rainfall. [3] It also leads to the melting of the arctic and antarctic glaciers which leads to rising sea levels. According to the IPCC Report 2022, over 3 billion of earth's population will be affected by climate change which is more than 1/3rd of the world's population. [4].

2. Emission from the Building Industry/Building Energy Codes

The Buildings and building-related industries were liable for 38% of global emissions in 2015 which decreased in 2020 and accounted for 36% of the total global CO₂ emissions in the form of embodied and operational carbon. [5] In 2015 Paris Agreement was made to ensure the rise of the global temperature by 1.5 degrees (that lowers 10 cm rise in predicted sea level) rather than 2 degrees. Every degree rise can make irreversible changes that can wipe out entire

ecosystems. The agreement is a small effort made by the governing bodies of developing and developed countries. [6] According to the 2021 Global Status Report for Buildings and Construction, 80 countries have mandatory building codes for energy consumption but only 15 countries have accepted and applied the necessary measures of building energy codes. [7] The oil resources are depleting and the world needs new energy resources. Architecture being a large part of the energy consumption criteria is an alarming factor and immediate steps are being taken to reduce the negative effects.

3. Leed and Breeam

There are certain criteria to be considered while designing a building. To ensure the sustainability of the buildings and to make real-time differences in energy consumption of buildings, LEED and BREEAM are two of the major associations that work to certify buildings by following certain standards. LEED is a US-based sustainable building organisation that has six basic goals. It is point based from 1-100; a rating that starts from only Certified to Platinum. [8] The main goal is to reduce the contribution to the global climate crisis by reserving water resources, creating safe healthy environments for people, saving biodiversity and environmental conservation, using sustainable materials, and creating better communal life. While BREEAM is a similar corporation working mainly in Europe. Its goals are based on United Nations Sustainable Development Goals, also known as SDGs. These goals regulate the new buildings and renovation of old buildings into taking necessary sustainable steps.

4. Material Usage Now & in Future

The usage of materials is considered to be one of the major factors affecting climate change. Modern society chooses to build houses with concrete and steel. Looking back from the history of materials usage; a shift can be seen from using locally sourced and easily transported materials to mass produced materials such as concrete and steel; that not only is becoming a major accelerating factor in global crises but also changes the land topography. Steel production requires 70% more energy to be produced than recycles steel. [9] One ton of cement production releases 800 kg of greenhouse emissions. [10] The effects of the irresponsible usage of harmful materials should be measured through scientific methods covering every aspect that it is affecting (such as water, energy, soil, heat etc). There are many biocompatible and eco sustainable materials and methods. Biocomposite materials are such that can be easily degraded in the environment without causing significant harm to the earth. Rammed earth, biomass, bamboo and straw bale are a few materials that are cost effective and sustainable.

In a study to improve the thermal insulation of rammed earth through fibres, arlite (expanded clay aggregate with honeycomb structure inside) is added and with 12.2% (the insulation index increases 25%). [11] Other stabilisers such as

natural cork, almond shells and olive stones increase the diversity of aggregate with sizes ranging from 0.5-9cm on granulometer. Rammed earth becomes stronger with different sizes of aggregates. Though the quality of the rammed earth is extensive due to varying soil quality in relation to conductivity indexes. It is also hygroscopic and keeps the humidity of a space at a comfortable level.

The usage of concrete, bricks and other manufactured building blocks causes emission of toxic gases like CO₂, sulphur derivatives directly in the atmosphere. [12] Biomass has been used as a material in building construction since the earliest of time. In this age, more than 50% of the waste is the solid waste biomass derived from the food production of the world. China, India and USA are the world's biggest crop producing countries but very few percent is recycled or used as building construction material. [13].

Some old techniques are still implemented and prevalent across Asian, African and South American countries due to lack of supposedly permanent resources such as concrete and steel. New stronger and responsible technologies were started from 1974 researched as Agricultural Waste Biomass (AWB) to create sustainable substitutes for concrete block and red bricks. [14].

According to AWB, the by-products come as ash, straws and other forms. Straw is considered a very important material for reinforcement substitute as it contains high content of fibre. It can be taken from different main crops like wheat, rice, coconut and maize husk, sugarcane bagasse, maize cob and oil palm shell. The cereal crops of wheat, maize and sorghum are the main sources for straw. It is water and moisture resistant and when bundled can create a good insulation material. Straw has been the basic building material in creating vernacular architecture. In the US, a thickness of 100 kg/m³ is preferred if straw bale construction method is used. U-value is the rate of heat transfer in a structure. The lesser the U-value, the more insulated the building is. The U-value of a straw bale wall is 0.13 W/M²K compared to cement which has a 0.4 W/m²K (three times higher than strawbale wall). It has great acoustic insulation properties as well as structural strength. [15] In the US alone, 200 million tonnes of straw bale is burned every year. Each bale of approx 1000 lbs with 40% carbon content can cause a total of 177k tonnes of CO₂ emission in the air.

Sustainable construction often leads to vernacular style. That can be seen in many examples in the works of Kengo Kuma. Leaning towards sustainability does not mean to cut off concrete and steel completely. Sustainability in architecture can be defined as the complete lifecycle of building. It can be considered as the source which will have the least carbon effect on the earth. Six initiatives were given in the First International Conference of CIBTG16 in 1994 for an ethical way for building. [16] From the initial construction phase to the transportation of the materials to the ethical ways of dealing with the workers and to lastly, the operations of the building; it has to have as minimal ecological footprint (EF) as possible and this is what makes a life cycle of a building eco friendly. Net Zero is another term used to define the building's total carbon footprint through embodied and operational

carbon, being off-set either on-site or off-site. In this way, a building's energy consumption is being equated into renewable energy resources and it is titled as ZNE (Zero Net Energy). [17].

With the advent of new biodegradable and sustainable materials, a new method of integrating renewable energy with these materials is also being researched. Ash is widely used for making blocks and brick replacement. It can reduce waste burning and ever-increasing landfills. These bio-based products use technology that takes advantage of the material on a cellular level by combining it with other materials for strength and increasing bearing capacities. Rice husk ash (RHA) is a major agricultural by-product in rice producing countries. It is used as bricks in a ratio with sand and cement. Steel that is used for reinforcement can be used as a conductor or as an electrode. Different other electrodes can also be used such as graphite. The white cells are fueled by Ammonium chloride 0.3 g/ml. [18] Every single white cell (every brick) produces energy and it can have a major effect on energy consuming markets. With the abundance of energy, there could be lots of options and new inventions can be easily accessible and accepted. This can be followed in pursuit of another question, what kind of spaces will humans be living in the future.

5. Changes in Urban Life / Design Decisions

The advancements in the world are at an astronomical pace and with all these developments, there is a massive change in the urban patterns. The living style of people has changed drastically. The buildings in the United Kingdom that were made for the cold, harsh winter of Europe have to suddenly comply with the drastic changes in climatic situation and suit according to the heatwaves that hit Europe every year. The people who are most affected by this climate crisis and the crisis of not providing the right means of living are mostly the elderly and the people with less resources. The governments have to take actions regarding the densely populated areas, that is, the cities. The climatic anomaly displaces 33 million people in Pakistan alone out of 225 million. [19] West Africa saw its worst flooding in many years, displacing 1.4 million people in Nigeria. [20] Even developed countries like South Korea saw its main financial hub Gangnam drowning with non-stop rainfall leading to fatalities. [21] All of these extreme climatic devastating incidents have happened in 2022 alone. If the unnecessary exploitation of resources continues and measures to stop the CO₂ emission won't be taken, our earth can soon become an uninhabitable place.

In reference to all of these, according to the UN report, almost 70% of the population will be living in the cities. [22] This puts cities on the spot of social and financial vulnerabilities. Lack of fresh water and housing crisis are only a few things to be mentioned. For the accommodation of people, new divergent ways must be uncovered and designed. Climatically responsive steps are taken by the government

with the help of architects, engineers, urban planners etc. People from all walks of life have to decide over the influx of people migrating towards the urban centres.

The most important part is to create renewable energy sources and reduce the energy consumption since energy will be the biggest problem faced by urban life and densities. Integration of photovoltaic cells (PV cells) in the design while keeping the architectural integrity alive can be an influential source of renewable energy. These photovoltaic cells can also be offgrid but in many countries, PV cells are already providing energy to many small villages in the world. And it is also integrated into big projects as well. The Plus factory designed by Bjark Ingels has the highest BREEAM rating of "Outstanding". This factory's major energy is from the 900 solar panels on top. It reuses 90% of water. [23] It follows all the goals set by BREEAM that aligns with the Sustainable Development Goals (SDGs).

Decarbonizing every field possible in urban areas can help in sustaining it. Automobile and air transportation causes 36.4 billion tonnes of CO₂ emissions. [24] The idea of a 15 minute city was given to combat and reduce the consumption of CO₂ through transportation. [25] 15 minutes city is an urban idea of having all the necessities in a 15 minute walking area. Basically, compact urban densities and multi functional spaces can be one of the solutions.

Sustainable means of food is also an important aspect. More agricultural workforce will migrate towards the cities for opportunities which can lead to a scarcity of farmers. In this situation, shortages of food can be a real problem. Since land is precious in the city, new ways of vertical farming can be integrated in the designs that not only will help people on community level but also increase the opportunity. [26] According to this research, some aspects have been shared to show the kind of materials, lighting and other features that can be used in architecture in the future cities of vertical farming. A self cleaning material (Ethylene Tetra fluoro ethylene) can be used. It is lighter than glass and lets 95% of sunlight in. Moreover, the building has to be at a certain height and angle to be provided with as much natural light as possible. Natural light alone is not possible for all the stacked plants hence artificial light can also be helped. It will be more controlled and sources from solar panels. Plantagon in Sweden was made to grow crops in high density areas. It combated this problem by rotating the swirling floors inside for equal sunlight.

6. Technology as a Tool (AI, Big Data)

The development of new materials is a laborious task and technological progress can help in achieving. While designing a building, there are many parameters to be analysed. BIM (Building Input Modelling) is a tool that helps us in building the structure and also input other data to simulate the building in real time at a place. AI can have effects on making our living conditions much better. Since AI is data driven, it can understand a human need in more depth. Zoning of the spaces can be done according to the needs and data already available. AI can also provide architects with solutions to functionally use

materials. It can also predict economic patterns to find the probability of the propitious time for building construction. Artificial Intelligence works on three levels: Symbolism (in which AI performs the basic functions of logic and engineering), Connectionism (It connects those decisions with neural network, machine learning etc) and Behaviourism (Optimizes every unit on perception-action control system). [27] The symbolism works as an analysis in which it can automatically create a core or a facade. In Connectionism, since it is all about the neural networks, it can experiment with the physical aspects of the building in real life. And finally, in Behaviourism, it learns and understands the fabric on a city scale.

Moreover, AI is a great tool to analyse the materials being used in a project. The compressive strength of cement varied according to the type of sand and aggregate. Additives are also added to increase the durability of the material. The strength is usually checked after 7-28 days of curing of the concrete but if the strength can be checked through AI technology before the setting on concrete; it could be cost benefit and less time consuming. [28].

According to another research, by using Artificial Neural Network (ANN), we can find out the strength. A material like concrete has a lot of components. All these components or variables are to be judged and taken into account. These variables are analysed and that data is put into a probability model. In this model, different possibilities are analysed either through a single model or ensemble model. Overall, AI can help architects to make better architecture as it can be a beneficial tool.

7. Conclusion

This research covered the current deteriorating climatic conditions that started first from the industrial revolution and with the discovery of plastic have only accelerated its effects. The urgency of the matters has led us to take quick actions regarding the state of the Earth as it is continuously becoming uninhabitable. The global emissions through construction is the biggest cause of climate change and global warming hence it is important for architects to take a stand against these practices. The practices of unethical ways of obtaining materials have been prevalent. The power authorities have unfortunately haven't been the architects. It is either the government or the stakeholders and every entity wants to draw out all the potential from a piece of land and hence harmful construction materials and methods are used. To eliminate such practices, architects and engineers have researched many sustainable alternatives.

The article first talks about the state of earth, then associations such as United Nations SDGs, LEED, and BREEAM are introduced to acquaint people with the sustainable goals and objectives of them. Since the material production, material transportation and appliance are the main causes of these CO₂ emissions, the materials topic is covered thoroughly where the detrimental effect of current using materials was pronounced and new sustainable materials and technologies were introduced. Then we look into the changes

that will occur in the urban densities. And lastly, we talk about the role of AI in architecture. By covering all of these aspects, we can say that passive technology is as important as AI. Research for new, durable materials must continue so that it can be mass produced without causing serious damage to our environment.

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