a) **Title of the project**: QUANTITATIVE ANALYSIS AND ASSESSMENT OF EMBODIED CARBON REDUCTION FROM RESIDENTIAL BUILDING

b) **Name of the College & Department:** NEW HORIZON COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

c) **Name of the Students & Guide(s**) (with email id and cell no. if any)

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d) Keywords:

Carbon emission, Embodied carbon, climate change, GHG, building construction, sustainable, conventional, reduction

e) Introduction / background (with specific reference to the project, work done earlier, etc) - about 20 lines

Carbon emissions have been identified as the main cause of global warming, which has grown to be a significant environmental problem for the community. As a result, the carbon footprint has drawn the attention of numerous researchers, particularly operational and embodied carbon reduction.

Every phase of a building's life cycle result in significant CO_2 emissions into the atmosphere: production of raw materials and finished goods, building construction, site preparation, use, exploitation, renovations, later rehabilitations, and finally demolition.

Due to increasing concerns about climate change, it is crucial in the current context to reduce carbon emissions from the building construction sector.

A key factor in limiting global greenhouse gas (GHG) emissions is achieving low carbon emissions in buildings.

Renovating the area to a higher standard or demolishing the building and replacing it with one that performs better are the two obvious alternatives for lowering the emissions of poorly-performing structures. Because ownership transfers occur more frequently in non-residential structures than in homes, the latter of these possibilities may apply to them more.

f) Objectives (about 10 lines)

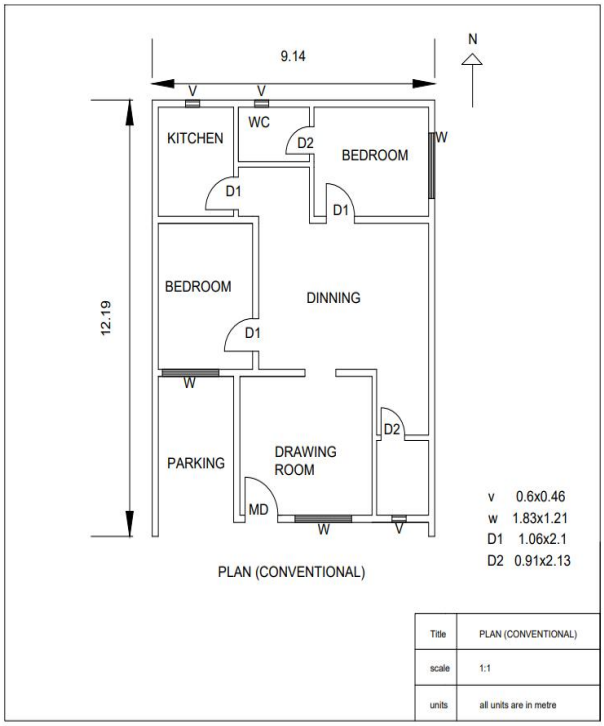
• The focus of this study is to examine ways of reducing CO2 emissions and embodied carbon related to building materials during the construction phase through the following strategies: - Considering building materials that can reduce the total weight of the building, which relatively will contribute to the reduction of the embodied carbon and the CO2 emissions such as concrete.

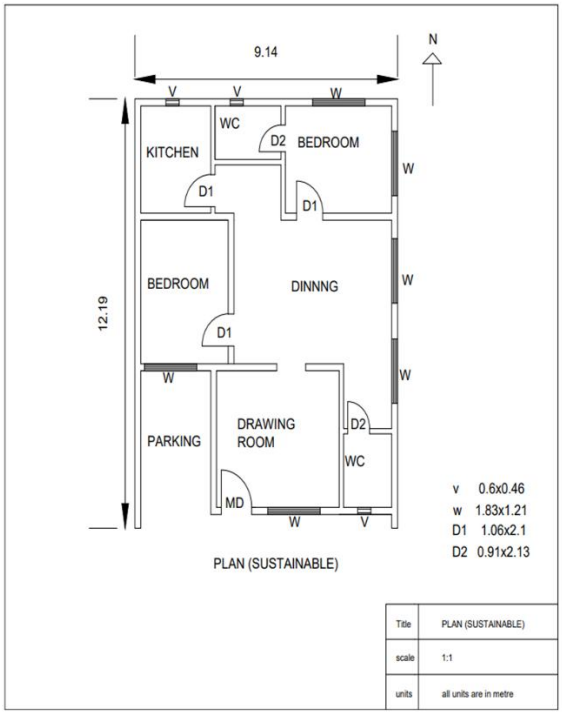
• Use low-carbon concrete mixes: Concrete can be the biggest source of embodied carbon for a new site, but lower-carbon concrete is easy to develop. By working with structural engineers, you can use fly ash, slag, calcined clays, or lower strength concrete if possible.

• Reuse materials: Second-hand materials such as brick, metal, wood and even broken concrete can make a big difference to embodied carbon emissions. These salvaged materials have a lower carbon footprint as the carbon used to make them has already been spent. Steel that is brand new has an embodied carbon footprint five times greater than recycled content steel.

g) Methodology (about 30 lines) (materials, methods, details of work carried out, including drawings, diagrams etc).

We are quantitatively analysing a conventionally built residential house to one constructed sustainably to determine the potential reduction in embodied carbon that straightforward substitutes can accomplish. To achieve this, we created a floor plan for residential construction, computed the material amounts, and multiplied those figures by the carbon factors we discovered while reading several publications. Our assessment of the embodied carbon in the sustainable building has shown reduction from the conventional one, which shows that simple substitutions can help not only with reduction in embodied carbon but also the overall cost of the building.





Materials used for conventional

1. **Conventional Block work:**

- A conventional concrete block, also known as a cinder block or concrete masonry unit (CMU), is a rectangular building material made of cement, sand, and water. It typically measures 8 inches (20 cm) tall by 8 inches (20 cm) wide by 16 inches (40 cm) long, but other sizes are also available.

2. **Cement plastering:**

- The production of cement, which is a key ingredient in cement plaster, is a significant source of greenhouse gas emissions. The process of manufacturing cement requires high temperatures and releases large amounts of carbon dioxide (CO_2) into the atmosphere, contributing to climate change.

3. **Concrete:**

- Portland cement production accounts for ~5–7% of total global anthropogenic carbon dioxide emissions. Therefore, the cement industry is an important target for emissions–reduction strategies.

4. **Terrazzo tile**:

- A type of flooring material known as terrazzo formed of aggregates, such as marble, granite, glass, or other fragments, embedded in a binder, usually cement or epoxy.

Material used for sustainable

1. **Clay plaster**: An old-fashioned method of putting clay-based materials to walls and ceilings as a finish is called clay plastering, sometimes known as clay rendering or clay plaster.

2. **CSEB -** Compressed Stabilised Earth Blocks is how they are known. It is an approach of building that uses compressed blocks made up of a combination of earth, stabilisers, and water.

3. **Cement with fly ash** -A blend of cement and fly ash, a by-product of the combustion of coal in power plants, is referred to as cement with fly ash. A pozzolanic substance called fly ash can be used to make concrete as an additional cementitious material (SCM).

4. **Ceramic tile**: ceramic tiles have a lower embodied carbon footprint than terrazzo tiles. Embodied carbon refers to the total carbon emissions associated with the manufacturing and transportation of a product, including the emissions from the extraction of raw materials, production, transportation, and installation.

h) Results and Conclusions (about 20 lines with specific reference to work carried out).

After comparing the values of conventional design and sustainable design we found the following, individually in the components we observed such as in block work we replaced conventional concrete block with compressed stabilised earthen block we saw a reduction of 81.24%, in plastering we used clay plaster instead of cement plaster and we achieved a reduction of 78.45%. In concreting of various components on the building we found by replacing cement by 20% fly ash we get 52.7% reduction in embodied carbon emission. In the case of flooring, we used ceramic tile instead of terrazzo tile due to its low carbon factor to show that the strength does not decrease when we use the replacement, we did compression test for concrete with fly ash and reclaimed aggregates and we achieved 35.9 MPa for M30 grade concrete. We achieved almost 57.87% of reduction overall in the embodied carbon.

item	Embodied carbon (conventional) Co_2e/kg	Embodied carbon (sustainable) Co_2e/kg	Percentage of reduction
Block work	3295.68	618.128	81.24%
Plastering	2263.68	487.645	78.45%
Concrete	21252	10052.196	52.7%
Flooring	1343.085	701.885	47.7%
Total	28154.445	11859.854	57.87%

Reduction percentage= (original value -new value)/ (old value) x 100
= (28154.445-12501.054)/ (28154.445) x100
= **57.87%**

i) What is the innovation in the project?

There are several methods for lowering the amount of carbon that is embodied in construction, such as using low-carbon building materials, using less energy and trash, and designing structures to be reusable and adaptable. Utilising recycled or renewable materials, maximising the form and layout of buildings to minimise material usage, and obtaining materials from nearby suppliers to avoid transportation emissions are a few typical methods for decreasing embodied carbon.

From the above tabulation we found that by substituting plain concrete, conventional brick, cement plaster and ceramic tile with concrete with 20% fly ash, CSEB, clay plaster and terrazzo tile we were able to achieve a reduction of 57.87%.

j) Scope for future work (about 20 lines).

The importance of embodied carbon has increased significantly for both business and government. By 2050, it is anticipated that embodied and operational carbon emissions will be equal, even though construction presently contributes 11% of greenhouse gas emissions due to planned growth in building projects over the next few decades.

There are now easier and less expensive techniques to minimise operational carbon, but not embedded carbon. Therefore, it is crucial to embrace new, straightforward strategies for lowering embodied carbon.

Carbon emissions have been identified as the main cause of global warming, which has grown to be a significant environmental problem for the community. Every phase of a building's life cycle result in significant CO_2 emissions into the atmosphere: production of raw materials and finished goods, building construction, site preparation, use, exploitation, renovations, later rehabilitations and finally demolition. Due to increasing concerns about climate change, it is crucial in the current context to reduce carbon emissions from the building construction sector.

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