



Impact Analysis of Residential Building Materials on Environment using BIM and LCA

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ABSTRACT –

The carbon emissions produced by construction of a building can significantly impact the environment. As per studies, 40 percent of annual worldwide CO₂ emissions are produced by the built environment. In the construction industry, cement is one of the commonly used building materials and a key component in concrete mix. In the world, cement is responsible for around 7% of global carbon emissions. Climate change is mostly caused by carbon emissions. The carbon emissions from the building can be reduced by replacing high carbon emission materials with sustainable building materials and less environmentally impactful materials. The choice of building materials can have a big impact on the environment. The carbon footprint of a building can be decreased by selecting materials that are durable, have minimal embodied carbon, and are obtained responsibly. Also, employing energy-efficient design and building techniques can lower carbon emissions over the life cycle of the building. In this paper, we study about impact analysis of building materials on the environment by determining the carbon emissions analysis. This was performed by changing several parameters to identify the parameters with the largest impact on a building. A comparison of the life cycle carbon emissions for each material can be done by using BIM and OneClick LCA software. The combination of BIM and LCA can be useful to determine the carbon emissions at the early design stage of the building by taking material quantities from a designed G+1 building model and life cycle assessment can be done by using OneClick LCA software to design a sustainable building.

Keywords – Building Information Modelling, OneClick LCA, Life cycle assessment.

1. INTRODUCTION

1.1 Life cycle assessment

Life cycle assessment (LCA) of a building is a comprehensive analysis of the environmental impacts associated with a building's entire life cycle, from the extraction of raw materials, construction, operation, and maintenance to its eventual demolition and disposal. LCA can help architects and builders make more informed decisions about building design, construction materials, and energy-efficient systems. By considering the entire life cycle of a building, LCA can also help identify opportunities to reduce the environmental impact of the building throughout its life cycle. An evaluation of a product's overall environmental impact is known as a life cycle assessment (LCA). By specifying a scope of analysis for each type of building or fabrication technique, each type of manufacturing or building material, as well as for each step of the building or method's life cycle, an LCA is able to evaluate energy consumption and environmental pollutant emissions [1].

Building life cycle stages

Building life cycle stages are mainly divided into four stages they are

1. Production stage
2. Construction stage
3. Use and maintenance stage
4. End of the building life stage

Production stage

In this stage, natural resource extraction has a significant impact on the availability of non-renewable resources and may cause their depletion. In addition, a lot of water and energy are used in this process. It has been estimated that the production of construction materials is one of the industries with the highest energy consumption on a worldwide scale.

Construction stage

The building's shape begins to take shape during construction. Building construction involves a large number of parties and necessitates a significant investment of time, resources, and labour.

Use and maintenance stage

The use stage of the building life cycle is typically thought to be the longest. This step includes tasks like maintenance and is described by circular solutions like reuse, repair, and refurbishment to increase the building's lifespan. The stage of use results in an environmental impact carried on by the users and the building's physical aspects.

End of the building life stage

End of the building life is also called demolition. Demolition is how buildings reach their end of life. Massive amounts of bulk garbage after demolition can be repurposed, reused, or just dumped. hence, they can be reused, repaired, remanufactured or recycled.

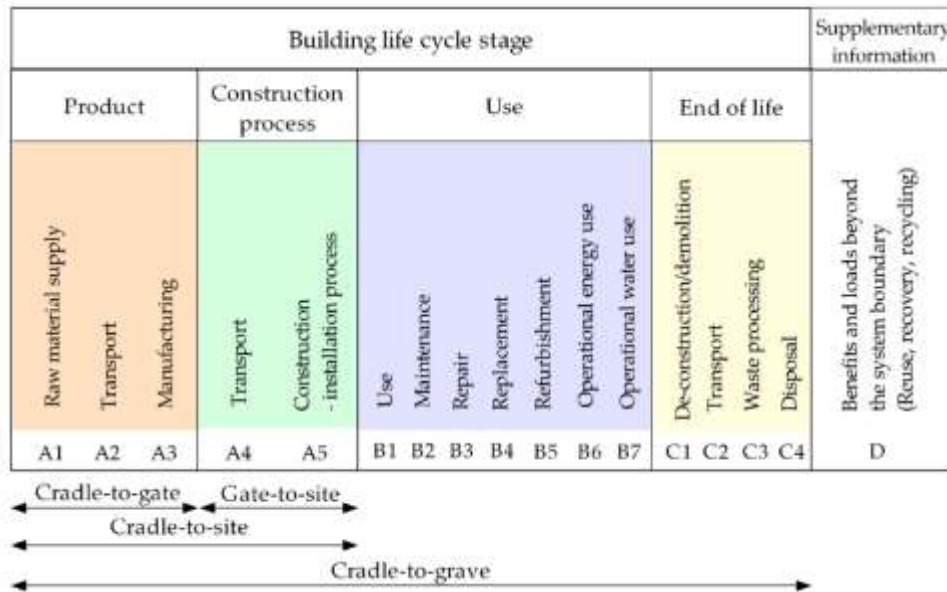


Figure 1. Building life cycle stages

1.2 BUILDING INFORMATION MODELING

Building information modelling, or BIM, is a building design technology that starts with creating an intelligent 3D model. BIM is a continuous process that involves throughout the life cycle of the building from planning stage to the demolition stage. BIM allows architects, engineers, contractors, and other construction professionals to collaborate on a project in a more efficient and effective way. BIM software users can generate a 3D model of the structure that contains information about its walls, doors, windows, and plumbing systems. Data on the building's materials, costs, schedules, and maintenance requirements can also be included in BIM. Early problem detection is beneficial since it can help save time and money. BIM is also used in facility management to monitor upkeep and repairs as well as to help reduce energy consumption.

1.3 REVIT

Revit is a BIM integrated software. It is used by architects, engineers, construction professionals, and designers to create detailed 3D models of buildings, infrastructure projects, and other structures. The ability to use parametric design is one of Revit's core characteristics. This means that adjustments made to one area of the model automatically affect the schedules, sections, and elevations of the entire model. When changes can be done fast and easily without having to manually update every view, this can save time and minimise errors. Moreover, detailed construction documentation like floor plans, elevations, sections, and schedules are produced using Revit. Contractors and subcontractors can utilise these documents to carry out the project.

2. LITERATURE REVIEW

Changhai Peng (2015), In this case of study, the whole life-cycle of a building was done by using BIM and Ecotect softwares. The goal of this study is to determine the CO₂ emission of a building in 3 stages they are construction, operation and demolition stage. 1. Approximately 85.4% of the total carbon emissions were generated during operation stage. 2. Sensitivity analysis was performed by varying several parameters to identify which parameter had the greatest impact on the building's performance [1].

Salman Azhar, Wade A. Carlton a, Darren Olsen a, Irtishad Ahmad (2010), In this exploratory study, the Perdue School of Business building at Salisbury University served as the case study to show how BIM can be used for sustainable design and the LEED® certification procedure. In order to establish the connection between BIM-based sustainability assessments and the LEED® certification procedure, a conceptual framework was first created. Secondly, this case study was used to validate the framework. The findings of this study suggest that the outcomes of BIM-based sustainability analysis software may be used directly or indirectly in the preparation of documentation supporting LEED® credits. By streamlining the LEED® certification procedure, it is possible to save a significant amount of time and money compared to the conventional approach [2].

Tove Malmqvist, Mauritz Glaumann, Sabina Scarpellini, Ignacio Zabalza, Alfonso Aranda, Eva Llera, Sergio Díaz (2010), this paper study about the uses a systematic approach to lead the user through the Life Cycle process while delineating key issues that frequently cause confusion, such as the selection of an assessment tool, the definition of system boundaries, the options for reducing the complexity of the process, etc. The ENSLIC Building Project served as the framework for developing the recommendations. In LCA adoption, it may be preferable to start with a more basic LCA tool, as presented in this paper's discussion of the recommendations. A simplified tool that just computes, for instance, CO₂ emissions for a portion of the life cycle may nonetheless help people comprehend the advantages of LCA and pique their interest. Just the input data are relevant to the impact. The user needs to be aware of this fact, for example, if numerous building supplies are missed. Such simplifications must be grounded on pertinent and well-supported hypotheses about which processes might be crucial and which might not [3].

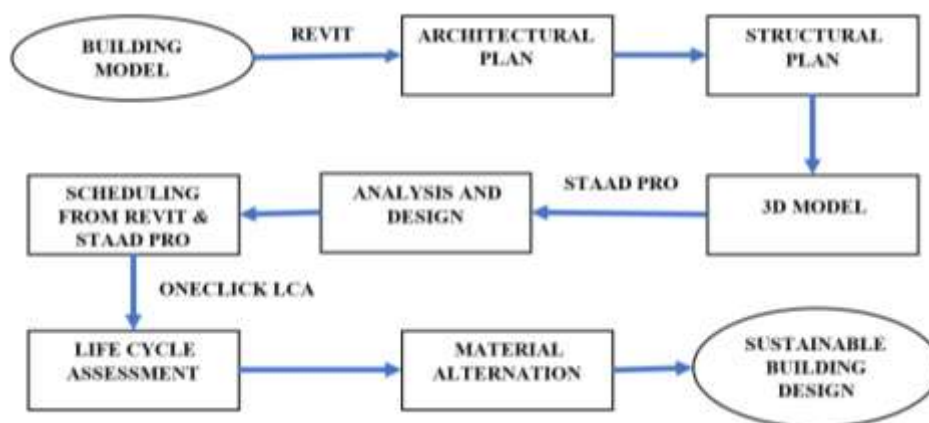
Ahmad Jade, Farzad Jalaei (2013), This study proposes a strategy for creating sustainable construction projects that combines BIM and LCA technologies with a database. The technique outlines the creation and application of a model that includes a database where data on sustainable materials is kept and is connected to a BIM (3D) module, an LCA module, a certification and cost module, and other modules. This model aims to streamline the procedure for developing environmentally friendly designs and to assess the environmental impacts (EI) of newly constructed structures at the conceptual stage of their lifespan. The model is straightforward and user-friendly, and it minimises user inputs and error prediction. Some of its benefits include time savings, quick calculations, and professional output reports. [4].

Patrick Bynum; Raja R. A. Issa, F. ASCE; and Svetlana Olbina, A.M. ASCE (2013), The purpose of this study is to find out how designers and builders feel about using BIM for environmentally friendly design and construction. To ascertain the current trends of BIM application generally as well as its use as a tool in sustainable design and construction, a survey was created and distributed via the Internet. According to the survey's results, majority (89%) of the 123 respondents used BIM, and more than half (51%) of them had been doing so for more than three years. Although the majority of respondents (63%) strongly agreed that sustainable design and construction methods were vital inside their companies, most still thought that project coordination and visualisation were more crucial than sustainability as a key application of BIM [5].

Lura Alvarez Anton, joaquin Diaz (2014), in this study two effective techniques, BIM and LCA, will be highlighted. These techniques can be quite helpful in the context of sustainability. One the one hand, BIM encourages integrated design and enhances information sharing and collaboration among the various stakeholders during the various project life-cycle phases. LCA, on the other hand, is an appropriate technique for evaluating environmental performance. The first technique, which is based on the assessment of the full construction life cycle, is more accurate despite being more difficult, and further research is needed in this area, it can be said of the two ways that have been provided for integrating LCA and BIM. In the early design phases, when choosing materials, products, and elements, the second approach, which is mostly material-oriented, can be considered as a way to incorporate environmental requirements on the same level as other characteristics [6].

Reijo Miettinen, Sami Paavola (2014), In this paper they analyse first the rhetorical-promotional dimension of the BIM implementation sometimes characterized as a "BIM utopia." Second, they analyse the views of the enhancement of BIM implementation. Although BIM visions and promises are needed for BIM implementation. The two methods have different ideas on how to improve the use of BIM and learning associated with it. The normative framework is based on tiers of standards that specify the best or most advanced stage of technological development, training, and descriptions of BIM use cases where savings, efficiency, and benefits have been realised [7].

3. METHODOLOGY



METHODOLOGY FLOWCHART

3.1 OBJECTIVES

- The main objective of this project is to design a sustainable residential building by alternating the building materials to reduce Environmental impacts at the early design stage of a residential building using BIM and LCA.
- In this project the carbon emissions (CO₂e) of a residential building can be determined by using OneClick LCA tool and the high CO₂e materials are replaced with energy efficient materials to improve the health of the planet and reduce Global warming.

The following steps are involved in this project

1. To create a Residential building in Revit.
2. Analysis and design of building model using STAAD Pro.
3. Extracting all the material quantities from Revit and Staad.
4. Life cycle assessment of the modeled residential building using OneClick LCA.
5. Correlation study of life cycle assessment with building quantities.
6. Altering the building materials to reduce environmental impacts.
7. Finally design the sustainable G+1 residential building.

3.2 METHODOLOGY

1. ARCHITECTURAL PLAN

In this step the building model is developed by using BIM integrated Revit software. In this process first grids and levels of building are prepared and next by selecting wall material plan is developed as per the G+1 building model. Finally, by selecting door, roof, floor and other components building design is completed.

2. STRUCTURAL PLAN

After completion of building plan in Revit the structural plan of the building is prepared in Revit Structural template by using beams, columns, roof and slab components.

3. 3D MODEL

After completion of G+1 building plan in Revit architecture and Revit structures the 3D model of the building is automatically developed.

4. ANALYSIS AND DESIGN

In this step analysis and design of G+1 building is done by preparing a structure and assigning the loads using StaadPro. The staadpro readings gives the material quantities of beams, columns and footing as well as reinforcement details.

5. SCHEDULING

Schedule of material quantities are prepared by using Revit and staadpro results and these schedules are used for calculation of life cycle assessment of a building by determining the carbon emissions of a building materials.

6. LIFE CYCLE ASSESSMENT

In this stage the life cycle assessment of a building is carried out by giving inputs of the material quantities and determining the carbon emission of a G+1 residential building by using OneClick LCA tool.

7. MATERIAL ALTERANATION

In this stage a study is carried out on building materials by analysing the building materials which have high carbon emission to the environment and the materials are replaced with less impactive materials to reduce carbon emission.

8. A SUSTAINABLE BUILDING DESIGN

Finally, the residential building design with less environmental impactive building materials to the environment is to be suggested as Sustainable building for construction.

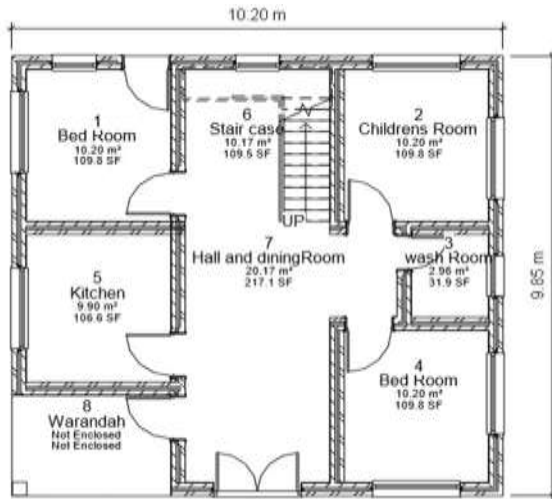


Figure 2a. Ground floor plan

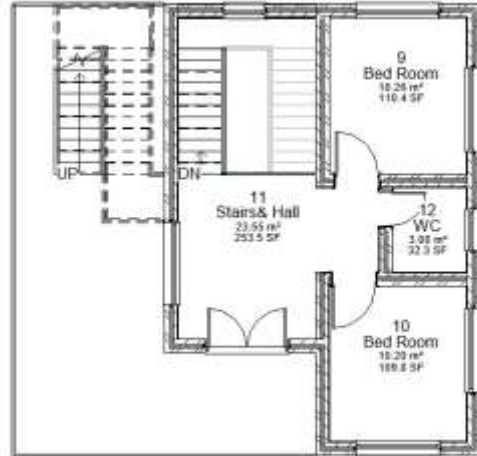


Figure 2b. First floor plan

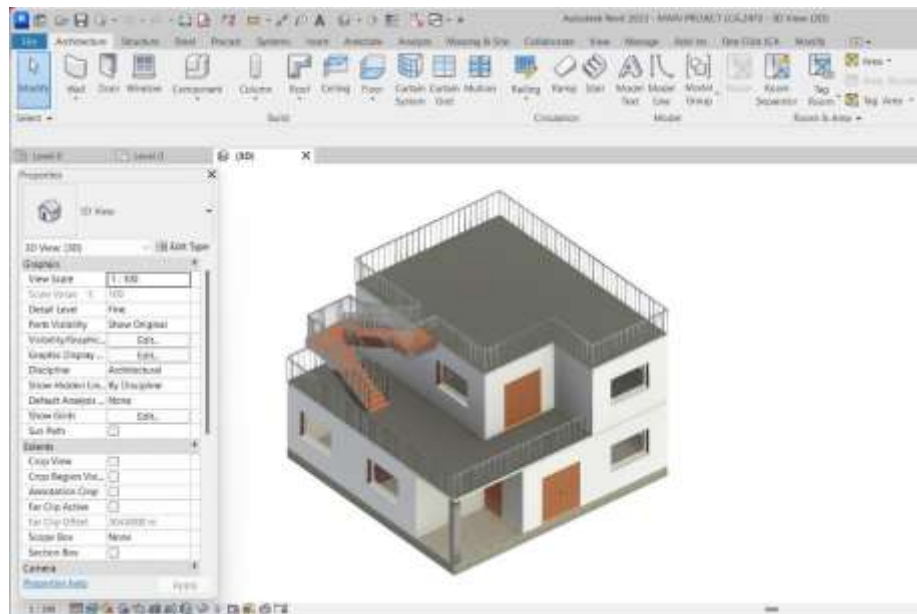


Figure 2. G+1 building 3D model



Figure 3. Building elevation south facing

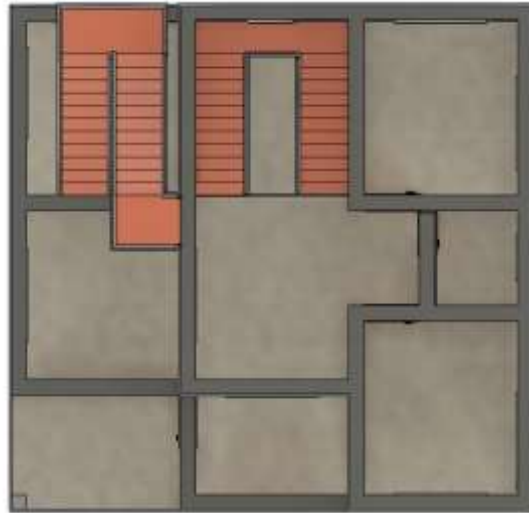


Figure 4. Building top view

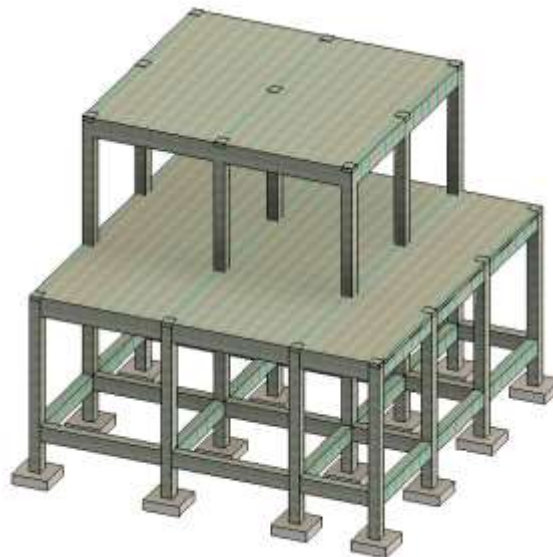


Figure 5. Structural drawing

Material quantities

Footing: (from Staad Pro)

Concrete quantity = 14.5 m^3

Steel quantity = $0.8 \% 14.5 = 0.116 \text{ m}^3$

steel weight = $0.116 * 7850 = 910 \text{ Kg}$

Columns and beams: (from Staad Pro)

Concrete quantity = 35 m^3

Steel weight = 2054 Kg

Roof or Slab and floor quantity: (from Revit)

Roof quantity = 19 m^3

Steel quantity in roof = $0.8 \% 12.5 = 0.1 \text{ m}^3$

Floor quantity = 45 m^3

Walls: (from Revit)

Brick volume = $75.8 - 34.8 = 41 \text{ m}^3$

No of bricks = $41 / 0.002 = 20500$

Total weight = $20500 * 3.2 \text{ Kg} = 65600 \text{ Kgs}$

Staircase:

Concrete Quantity = $1 * 0.25 * 0.17 * 48 = 2.04 \text{ m}^3$

Steel quantity = $0.8 \% 2.04 = 0.01 \text{ m}^3$

Gross floor area of a building = 100 m^2

Table 1. Material quantities

Description	Length m	Width m	Depth m	No's	Quantity m^3
Footing	-	-	-	-	14.5
Columns	-	0.3	0.3	-	10
beams	-	0.3	0.45	-	27
floor	10.2	9.85	0.45	1	45
roof	10.2	9.85	0.125	1	19
bricks	0.2	0.1	0.1	20500	41

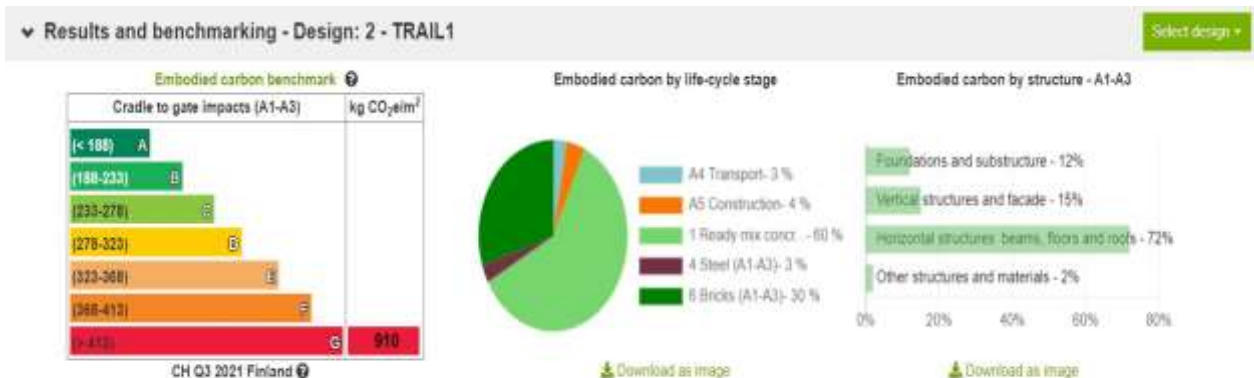
4. RESULTS AND DISCUSSION

LIFE CYCLE ASSESSMENT OF A RESIDENTIAL BUILDING

Trail-1: materials with average CO₂e

- Ready mix concrete for beams columns and slabs GWP of 0.11 Kg CO₂e / kg
- Clay bricks GWP of 0.24 Kg CO₂e / kg for walls
- Reinforcement steel (rebar) with GWP of 0.91 Kg CO₂e / kg

 91 Tonnes CO₂e

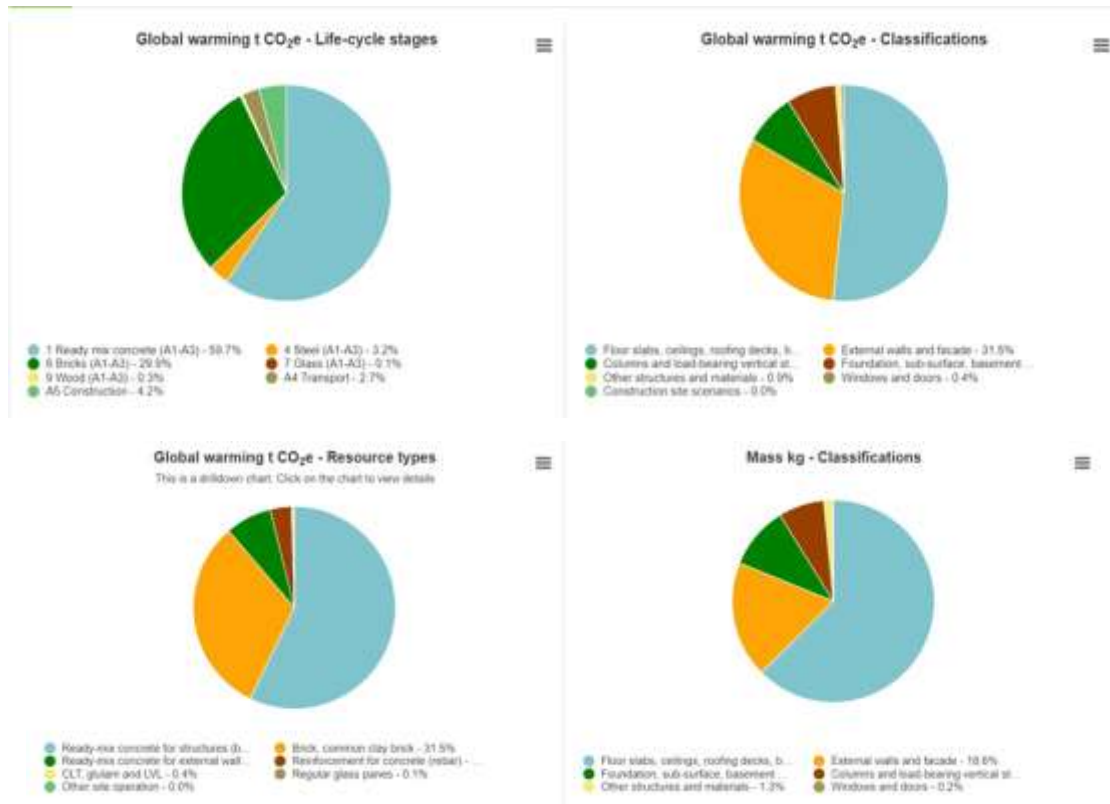


Results

One Click LCA Planetary results [Download Results Summary](#)

One Click LCA Planetary reports the product cradle to gate (A1-A3) carbon impacts as well as material efficiency for your project. Biogenic carbon is not deducted from totals. You can compare number of designs to identify the most environmentally sustainable design, material and/or supplier. Results are also displayed per m² Gross Internal Floor Area, if you have inputted area.

Result category	Global warming tCO ₂ e	Global warming kg CO ₂ e/m ²	Mass of raw materials t	Mass of raw materials kg/m ²
1 Ready mix concrete (A1-A3)	54	543	287	2,855
4 Brick (A1-A3)	3	28	3	30
8 Bricks (A1-A3)	27	272	68	688
7 Glass (A1-A3)	0	0	0	0
9 Wood (A1-A3)	0	0	1	8
A1-A3 Construction Materials	85	847	356	3,559
A4 Transport to the building site	3	34		
AC Construction/installation process	4	38	10	100

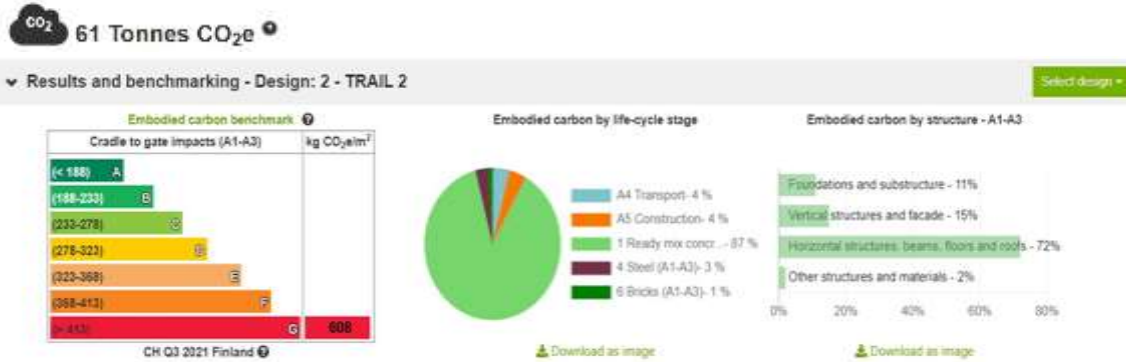


Most contributing materials (Global warming)

No.	Resource	Cradle to gate impacts (A1-A3)	Of cradle to gate (A1-A3)
1	Ready-mix concrete, normal-strength, generic, C40/50 (5900/7300 PSI), 20% recycled binders in cement (400 kg/m ³) / 24.97 (lb/ft ³)	1.9 t CO ₂ e	79.3%
2	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300 kg/m ³) / 18.72 (lb/ft ³)	0.27 t CO ₂ e	11.2%
3	Clay brick	0.15 t CO ₂ e	6.2%
4	Reinforcement steel (rebar), generic, 80% recycled content, A615	0.04 t CO ₂ e	1.7%
5	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 20% recycled binders in cement (300 kg/m ³) / 18.72 (lb/ft ³)	0.04 t CO ₂ e	1.5%
6	Glue laminated timber (Glulam), 544 kg/m ³ , 12% (vs 2%) moisture content	0 t CO ₂ e	0.1%
7	Float glass, single pane, generic, 3-12 mm (1/12-0.47 in), 16 kg/m ² (2.05 lb/ft ²) (for 4 mm/0.16 in), 2500 kg/m ³ (156 lb/ft ³)	0 t CO ₂ e	0.0%

Trail-2: materials with low CO₂e

- Ready mix concrete for beams columns and slabs GWP of 0.0899 Kg CO₂e / kg
- Reclaimed bricks GWP of 0.0059 Kg CO₂e / kg for walls
- Reinforcement steel (rebar) with GWP of 0.62 Kg CO₂e / kg

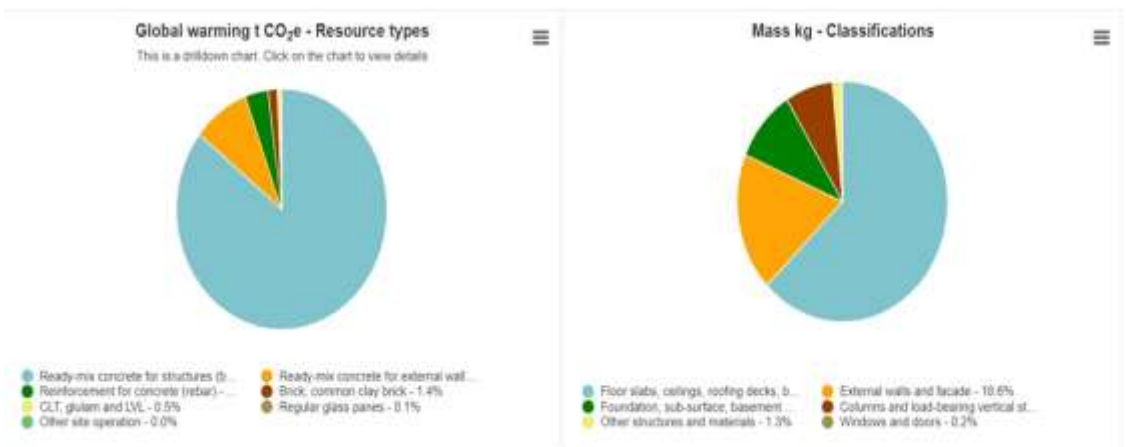


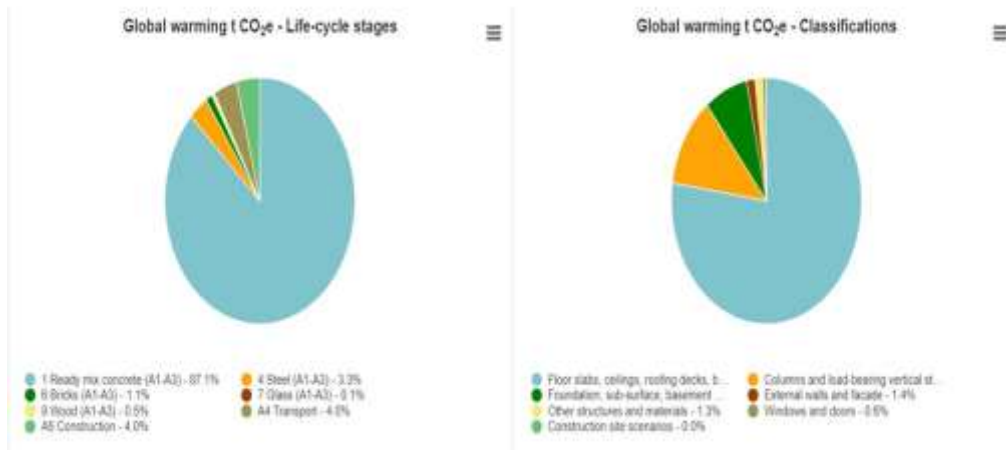
▼ Results

One Click LCA Planetary results Download Results Summary

One Click LCA Planetary reports the product cradle to gate (A1-A3) carbon impacts as well as material efficiency for your project. Biogenic carbon is not deducted from totals. You can compare number of designs to identify the most environmentally sustainable design, material and/or supplier. Results are also displayed per m² Gross Internal Floor Area, if you have inputted area.

Result category	Global warming t CO ₂ e	Global warming kg CO ₂ e/m ²	Mass of raw materials t	Mass of raw materials kg/m ²
1 Ready mix concrete (A1-A3)	52.91	525.12	296.8	2,660
4 Steel (A1-A3)	2.02	20.2	2.06	20.54
6 Bricks (A1-A3)	0.68	6.8	65.6	600
7 Glass (A1-A3)	0.05	0.47	0.02	0.2
9 Wood (A1-A3)	0.28	2.79	0.54	5.44
A1-A3 Construction Materials	55.94	555.37	355.02	3,000.18
A4 Transport to the building site	2.42	24.18		
A5 Construction/Installation process	2.41	24.14	14.94	140.43





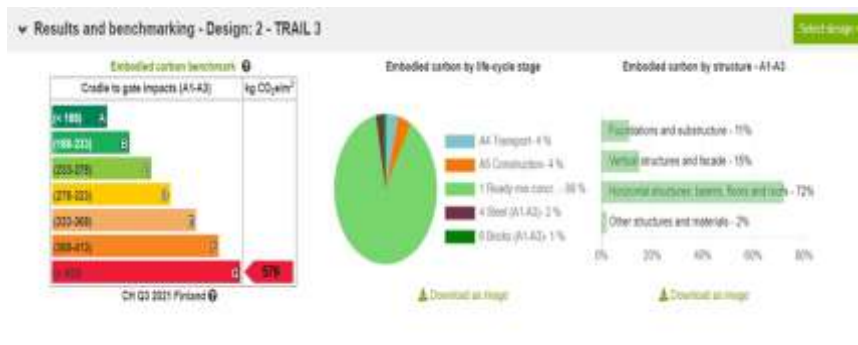
Most contributing materials (Global warming)

No.	Resource	Cradle to gate impacts (A1-A3)	Of cradle to gate (A1-A3)
1	Ready-mix concrete, normal-strength, generic, C40/50 (5800/7300 PSI), 20% recycled binders in cement (400 kg/m ³ / 24.97 lbs/ft ³)	1.9 t CO ₂ e	79.7 %
2	Ready-mix concrete, normal strength, generic, C28/35 (4000/5000 PSI) with CEM II/B-V, 30% fly ash content (300 kg/m ³ , 18.7 lbs/ft ³ total cement)	0.27 t CO ₂ e	11.2 %
3	Reclaimed brick	0.15 t CO ₂ e	6.2 %
4	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 20% recycled binders in cement (300 kg/m ³ / 18.72 lbs/ft ³)	0.04 t CO ₂ e	1.5 %
5	Reinforcement steel (rebar), generic, 90% recycled content, A615	0.03 t CO ₂ e	1.2 %
6	Glue laminated timber (Glulam), 544 kg/m ³ , 12% (± 3%) moisture content	0 t CO ₂ e	0.1 %
7	Reinforcement steel (rebar), generic, 97% recycled content (typical), A615	0 t CO ₂ e	0.0 %
8	Float glass, single pane, generic, 3-12 mm (0.12-0.47 in), 10 kg/m ² (2.05 lbs/ft ²) (for 4 mm/0.16 in), 2500 kg/m ³ (156 lbs/ft ³)	0 t CO ₂ e	0.0 %

Trail-3: materials with very low CO₂e

- Ready mix concrete for beams columns and slabs GWP of 0.0641 Kg CO₂e / kg
- Reclaimed bricks GWP of 0.0059 Kg CO₂e / kg for walls
- Reinforcement steel (rebar) with GWP of 0.42 Kg CO₂e / kg

CO₂ 58 Tonnes CO₂e



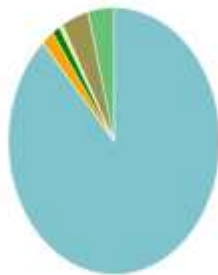
Results

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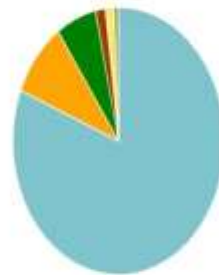
Result category	Global warming t CO ₂ e	Global warming kg CO ₂ e/m ²	Mass of raw materials t	Mass of raw materials kg/m ²
1 Ready mix concrete (A1-A3)	51.06	510.6	206.8	2,068
4 Steel (A1-A3)	1.12	11.15	2.05	20.54
6 Bricks (A1-A3)	0.08	0.8	65.8	656
7 Glass (A1-A3)	0.05	0.47	0.00	0.2
9 Wood (A1-A3)	0.26	2.79	0.94	9.44
A1-A3 Construction Materials	53.2	532.01	265.02	2,650.18
A4 Transport to the building site	2.40	24.18		
A5 Construction/Installation process	2.3	23.07	14.94	149.43

Global warming t CO₂e - Life-cycle stages



- 1 Ready mix concrete (A1-A3) - 89.2%
- 6 Bricks (A1-A3) - 1.2%
- 9 Wood (A1-A3) - 0.6%
- A5 Construction - 4.0%
- 4 Steel (A1-A3) - 1.9%
- 7 Glass (A1-A3) - 0.1%
- A4 Transport - 4.2%

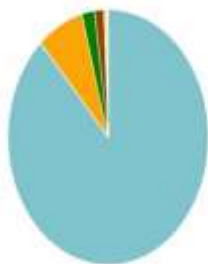
Global warming t CO₂e - Classifications



- Floor slabs, ceilings, roofing decks, b... - 89.2%
- Foundation, sub-surface, basement... - 1.2%
- Other structures and materials - 1.3%
- Construction site scenarios - 0.0%
- Columns and load-bearing vertical st... - 1.5%
- External walls and facade - 1.5%
- Windows and doors - 0.6%

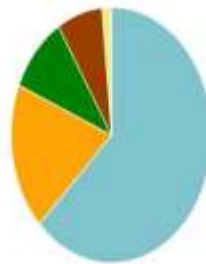
Global warming t CO₂e - Resource types

This is a drilldown chart. Click on the chart to view details



- Ready-mix concrete for structures (s... - 89.2%
- Reinforcement for concrete (rebar) ... - 1.2%
- CLT glulam and LVL - 0.6%
- Other site operation - 0.0%
- Ready-mix concrete for external wall... - 4.0%
- Brick, common clay brick - 1.5%
- Regular glass panes - 0.1%

Mass kg - Classifications



- Floor slabs, ceilings, roofing decks, b... - 89.2%
- Foundation, sub-surface, basement... - 1.2%
- Other structures and materials - 1.3%
- Windows and doors - 0.2%
- External walls and facade - 18.6%
- Columns and load-bearing vertical st... - 2.0%

▼ Most contributing materials (Global warming)			
No.	Resource	Cradle to gate impacts (A1-A3)	Of cradle to gate (A1-A3)
1.	Ready-mix concrete, normal-strength, generic, C40/50 (5800/7300 PSI), 20% recycled binders in cement (400 kg/m ³ / 24.97 lbs/ft ³) 🟡?	1.7 t CO ₂ e	72.0 %
2.	Ready-mix concrete, normal-strength, generic, C28/35 (4000/5000 PSI) with CEM III/A, 60% GGBS content (300 kg/m ³ , 18.7 lbs/ft ³ total cement) 🟢?	0.27 t CO ₂ e	11.2 %
3.	Ready-mix concrete, normal-strength, generic, C40/50 (5800/7300 PSI), 50% recycled binders in cement (400 kg/m ³ / 24.97 lbs/ft ³) 🟢?	0.19 t CO ₂ e	7.7 %
4.	Reclaimed brick, 🟢?	0.15 t CO ₂ e	6.2 %
5.	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 20% recycled binders in cement (300 kg/m ³ / 18.72 lbs/ft ³) 🟡?	0.04 t CO ₂ e	1.6 %
6.	Reinforcement steel (rebar), generic, 100% recycled content, A615 🟢?	0.03 t CO ₂ e	1.2 %
7.	Glue laminated timber (Glulam), 544 kg/m ³ , 12% (± 3%) moisture content 🟡?	0 t CO ₂ e	0.1 %
8.	Float glass, single pane, generic, 3-12 mm (0.12-0.47 in), 10 kg/m ² (2.05 lbs/ft ²) (for 4 mm/0.16 in), 2500 kg/m ³ (156 lbs/ft ³) 🟡?	0 t CO ₂ e	0.0 %

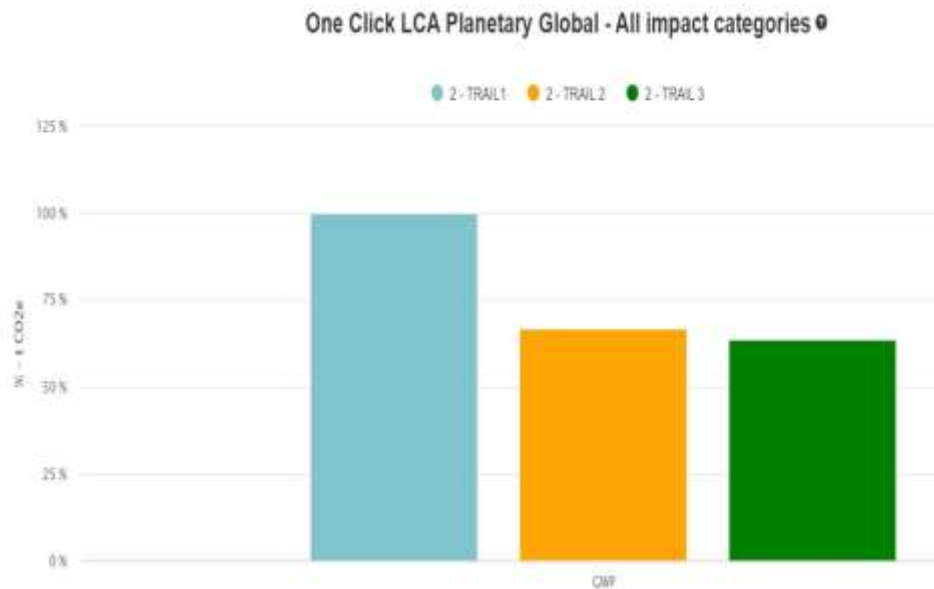


Figure 6. Carbon emission comparison

DISCUSSION

1. Building plan and 3d model are perfectly done by using revit software.
2. Building design is effectively did with the help of staadpro and material schedule is easily prepared with the help of Staadpro and Revit.
3. Building life cycle analysis performed with the help of OneClick LCA tool.
4. Trail 1 of average CO₂e materials with Ready mix concrete for beams columns and slabs GWP of 0.11 Kg CO₂e / kg, Clay bricks GWP of 0.24 Kg CO₂e / kg for walls and Reinforcement steel (rebar) with GWP of 0.42 Kg CO₂e / kg produce 91 tonnes of CO₂e.
5. Trail 2 of average CO₂e materials with Ready mix concrete for beams columns and slabs GWP of 0.0089 Kg CO₂e / kg, reclaimed bricks GWP of 0.0059 Kg CO₂e / kg for walls and Reinforcement steel (rebar) with GWP of 0.62 Kg CO₂e / kg produce 61 tonnes of CO₂e.
6. Trail 3 of average CO₂e materials with Ready mix concrete for beams columns and slabs GWP of 0.0641 Kg CO₂e / kg, reclaimed bricks GWP of 0.0059 Kg CO₂e / kg for walls and Reinforcement steel (rebar) with GWP of 0.42 Kg CO₂e / kg produce 58 tonnes of CO₂e.

5. CONCLUSION

BIM and One Click LCA software can be used to determine the life cycle of a building by calculating carbon emissions of each material. The combination of BIM and LCA might be helpful to calculate carbon emissions at the early design stage of the building. The revit software and OneClick LCA tools both are taking major role in this project. Revit scheduling can be help full to save time and gave more accurate material quantities and the OneClick LCA software can provide carbon emission of each material automatically when we give materials quantities. While comparing 3 trails with different materials trail3 gave satisfying results when compared to trail1 and trail 2. In trail 3 the building materials with Ready mix concrete for beams columns and slabs GWP of 0.0641 Kg CO₂e / kg, reclaimed bricks GWP of 0.0059 Kg CO₂e / kg for walls and Reinforcement steel (rebar) with GWP of 0.42 Kg CO₂e / kg will produce (58 tonnes of CO₂e) Less carbon emission to the environment so these materials can helpful to design a sustainable building and reduce the global warming.

6. REFERENCES

- [1] Changhai Peng (2014), "Calculation of a building's life cycle carbon emissions based on Ecotect and building information modelling".
- [2] Salman Azhar, Wade A. Carlton, Darren Olsen, Irtishad Ahmad (2011), "Building information modelling for sustainable design and LEED® rating analysis".
- [3] Tove Malmqvist, Mauritz Glaumann, Sabina Scarpellini, Ignacio Zabalza, Alfonso Aranda, Eva Llera, Sergio Díaz (2010), "Life cycle assessment in buildings: The ENSLIC simplified method and guidelines".
- [4] Ahmad Jrade, Farzad Jalaei (2013), "Integrating building information modelling with sustainability to design building projects at the conceptual stage".
- [5] Patrick Bynum; Raja R. A. Issa, F. ASCE; and Svetlana Olbina, A.M. ASCE (2013) "Building Information Modelling in Support of Sustainable Design and Construction".
- [6] Lura Alvarez Anton, joaquin Diaz (2014), "Integration of life cycle assessment in a BIM environment".
- [7] Reijo Miettinen, Sami Paavola (2014), "Beyond the BIM utopia: Approaches to the development and implementation of building information modeling".
- [8] Johnny Kwok Wai Wong *, Jason Zhou (2015), "Enhancing environmental sustainability over building life cycles through green BIM: A review".