Assessment of the Environmental impact, Energy performance and Economic aspect of building materials

Introduction:

This project was conducted to show the benefits of using environmentally friendly materials such as bio-based materials instead of fossil-based materials in the construction of having the same energy consumption, technical properties and prices.

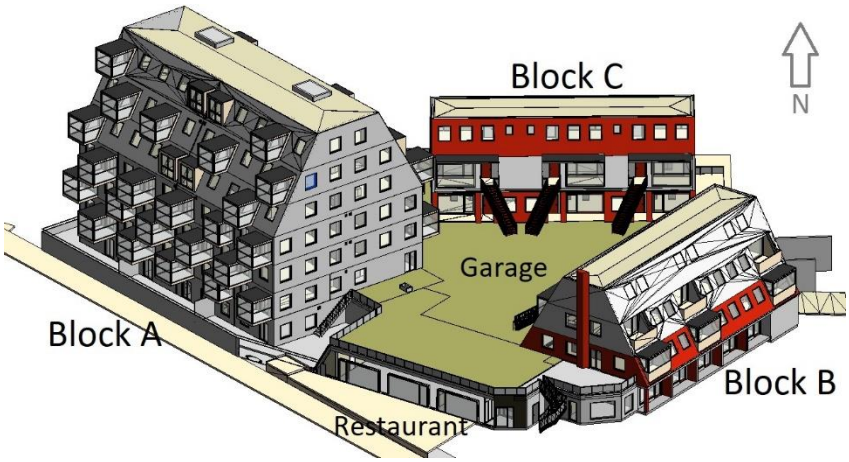

Figure 1: 3D model of the project (The main focus was on block A)

Methodology:

This study intends to assess the using bio-based materials instead of fossil-based materials for the thermal insulation layer of the external walls and roofs. Another focus of this project is using green concrete instead of normal concrete to save at least 30 % CO_2 emission for the foundation. The next objective of this project is applying the rectangular pre-insulated air ducting system instead of the normal steel galvanised spiral ducting system to improve the environmental impact of the HVAC system. The study is based on a residential building which has 3572 m² built area in 7 floors and the project is located in Karlskrona, Sweden. This study was performed in different sequenced steps of the quantities survey, selection of the materials, energy analysis, environmental assessment, economic analysis and future climate analysis. Based on the selected materials, 30 scenarios were defined and the energy simulation was performed for each scenario separately. After that, the primary energy need of the project was calculated based on BBR 26 for each scenario. To investigate the environmental impacts, the Life Cycle Assessment (LCA) was performed. The next step was assessing the economical aspect by the Life Cycle Costing (LCC) method. Then, by applying the Single-Point Rate (SPR) calculation, the best scenario was selected regarding the integration of primary energy number (EP_{pet}), LCA and LCC. Finally, the future climate analysis was carried out for the selected scenario to investigate the reliability of the selected scenario based on the future weather condition between 2070 and 2099.

Results and Discussion:

According to the results, the scenario which includes the bio-based material (wood fiber) for the insulation, green concrete for the foundation and rectangular pre-insulated duct for the air duct system was selected as the optimum scenario. This result was based on the equal importance of the EP_{pet}, LCA and LCC. In fact, this scenario demonstrated almost 15 % lower environmental impact than the scenario which is used fossil-based materials. On the other hand, if the economical aspect of the project is more important than the environmental aspect, the scenario with the fossil-based materials should be applied. The future climate analysis illustrated that the heating energy demand of the project will be decreased by 45% during the next 50 years, while the cooling energy demand will be increased twice. Therefore, the suitable infrastructure is expected for this project to be able to support the cooling energy demand of the building in the future. Also, the CO_2 emission due to energy use of the project is almost 14 % higher from 2070 to 2099. It is basically, because of increasing the cooling energy demand in this time period.