Course Name: Architectural Approaches to Decarbonization of Buildings

Professor: Dr. Iyer Vijayalaxmi Kasinath

Department of Architecture,

School of Planning and Architecture, Vijayawada

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Lecture 04

Comparison between conventional and alternate building materials

So, dear students we saw what are the non-renewable materials and how they become so carbon intensive. We saw how steel, concrete, glass, gypsum board are non-renewable materials and at the same time extremely energy intensive. Today we will look at case studies of non-renewable materials but not in the conventional way. I am not going to select case studies of buildings built with concrete or cement or steel to tell you how carbon intensive they are. You already know that. Today we will take case studies as comparison.

Some researchers have been done to understand how when a building is built using renewable material versus non-renewable material, how much is the impact it causes on the embodied carbon. So, today we will look at one of the works called Assessment of Alternate Building Materials which looks at what happens to the amount of operational energy and carbon dioxide emissions when alternate materials are used for the exterior walls. So in this case study, basically, we compare the similar building with different material and evaluating the environmental impact of each of those factors. So, that which helps us in identifying and selecting environmentally friendly materials.

In a standard building, up to 90% of the environmental impact occurs in the operational stage and mainly due to the heating and cooling procedures. Regulations have made the new strategies for energy efficiency of buildings and as a result other life cycle stages such as selections of material has become more important. Thus, selecting environment friendly building materials should be carried out as an appropriate basis of comparing building materials as objectively as possible in a quantitative way. This study was conducted on a typical four storied residential building in Tehran with a total area of 94.2 square meters.

The structural system was reinforced concrete system and now the comparison starts. So, in this study they have used simulation understand what happens when you use conventional building materials such as brick for wall versus clay block as an alternative

material. What happens to the building or embodied carbon when you use polystyrene as an insulation material versus glass wool. Synthetic and petrochemical paints which is oil based paints versus natural paints. Aluminum window frame versus wooden window frames.

Double glazed windows with air gap in between and double glazed windows with 6 mm spacing which is argon filled. After this where such assumptions are made. Now, the thermal energy consumption and carbon dioxide emissions of both this is compared both these case scenarios is compared, case 1 and case 2 scenario is compared using simulation it is calculated and compared. And the overall reduction in thermal energy consumption and carbon dioxide emission by using case 2 is done. So, this study attempted to know to use a quantitative method and a building model using a software say design builder to compare conventionally used materials with proposed new ones as given in case 2 that can act as an alternative to the exterior walls of a residential building.

The analysis focused mainly on thermal energy consumption and carbon dioxide emissions of the operational stage of the building. The selection of alternative building material is based on some other former research which showed which is a more environmentally friendly material. Now, we will understand small basics. Brick, these are mainly composed of aluminium silicate and are produced in the form of solid perforated or hollow rectangular cube or thin pieces. These are biodegradable thermal masses with low embodied energy.

Whereas clay block is produced by processing clay, shale or other suitable materials at 930 degree centigrade. They are good biodegradable thermal masses with very low embodied energy as compared to the thermal performance they would give. Petrochemical thermal insulation they are obtained from fossilized material. Polystyrene is a good example. They are non-biodegradable with high embodied energy and carbon dioxide emissions.

Whereas natural and mineral based thermal insulation are organic thermal insulations that are manufactured from natural materials such as cellulose, cork, sheep wool, wood etc., and also natural insulators that are made of minerals such as glass wool and mineral wool. They are biodegradable with relatively low embodied energy. Synthetic petrochemical paints have a lot of latent energy and release volatile organic compounds whereas natural and minimal paints mineral paints have a low latent energy. Aluminium frame is a soft light metal, silver coloured, lustred, highly formable and it is extremely energy intensive as we have seen in the previous classes.

Whereas when we use wooden frame, wood is an organic cellulose tissue composed of

50% carbon already sequestered. Synthetic petrochemical paints are made from non-renewable sources. They are non-biodegradable whereas natural and mineral paints they are made of renewable sources and they are non-toxic and biodegradable. Aluminum frames are very high embodied energy have very high global warming potential and wooden frames. They are one of the oldest building materials mankind has used and are low embodied energy with good thermal performance.

So, what did this study tell? Monthly thermal energy consumption and carbon dioxide emission of the building during one year was measured using certain instruments. In this paper, they have considered the rate of heat loss and optimization of consumption were only calculated for hydrocarbon fuels in the building sector. which mainly include diesel or natural gas. Electrical power use impact is considered on carbon dioxide emissions. So, this study monthly thermal energy consumption and CO2 emissions for the building material with conventional materials was calculated and the same was calculated using alternate materials.

you can see for every thermal energy consumption of a month the respective for the same month the energy consumption of alternate materials is less for each of the months respectively. This goes to show thermal energy consumption in a conventional in a building built with conventional material is higher than that built with alternate materials and by how much is proved here it's the same with carbon dioxide emissions also so here you can see monthly carbon dioxide emissions of alternate building materials is more or less lesser than the conventional one except some month there is an error this the colors are interchanged otherwise for every month using alternate building material, the monthly carbon dioxide emissions is less. The amount of annual global carbon dioxide emission in the building constructed with conventional material is 26,600 kg. While by using alternate material, the value would have decreased by at least 3%. It should be noted that carbon dioxide emissions in hot months increase due to growth in electricity power use.

You can see annual thermal energy consumption of the conventional building is higher than that of the alternate building and the comparison of carbon dioxide emission conventional buildings emit more CO2 than buildings built with alternate building materials for one year. So, from this study we can conclude that when we use alternate building materials the embodied energy of the building material is anyways less. The embodied carbon of the building material is anyways less. The energy consumption in the building built with alternate building materials is also less. Hence, alternate building materials which are made of renewable materials or materials which are low in embodied carbon are good for the environment as well as they do help the purpose.

So, we will stop here today. We had a short class because the paper was a little technical

and I did not want to make it very heavy. So, we will stop the class here today and we will continue in the next class. Thank you. Thank you.