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CASE STUDY OF LIFE CYCLE ASSESSEMNT FOR THE WORKING LABOURS IN A RESIDENTIAL BUILDING

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ABSTRACT

Nowadays, many construction companies are facing with ever stricter environmental impacts and changing, innovative material markets in which customers are being increasingly aware of environmental impacts. In today's societies the built environment accounts for 10% of global economic, activity, consumes 40% of the world's material and energy production, accounts for 70% of the fresh water consumption and uses 25% of the annual global wood harvest. As we know, the construction of a building consisting of many activities that begins with Earthwork and ends with handover of the building to the customer by the contractor. Hence it includes many different construction materials which cause great impacts to the environment. Not only the building materials, but also the pollution producing during the period of construction and demolition of a building creates largest impact to the surrounding environment.

Keywords: Life cycle; Greenhouse gas; Emission; Temperature

1. INTRODUCTION

1.1 GENERAL

Of the many environmental impacts of development, the one with the highest profile currently is global warming, which demands changes from government, industry and public [1]. Concerns about the local and global environment situation are rising all over the world. Global warming is the consequence of long term buildup of greenhouse gases (CO2, CH4, N2O, etc.) in the higher layer of atmosphere [2]. The emission of these gases is the result of intensive environmentally harmful human activities such as the burning of fossil fuels, deforestation and land use changes. This is generally accepted to be the reason that average global temperatures have increased by 0.74 °C in the last 100 years. Global temperatures are set to rise by a further 1.1 °C in a low emissions scenario, and by 2.4 °C in a high emissions scenario, by the end of the century [3]. It is necessary to reduce Green House Gases (GHG) emissions by 50% or more in order to stabilize global concentration by 2100 [4]. The Tyndall Centre has suggested that a 70% reduction in CO2 emissions will be required by 2030 to prevent temperature rising by more than 1 °C [6]. UK emissions of greenhouse gases fell by nearly 14.6% between the 1990 base year and 2004, but have risen by about 1 % since 2002, most recently because of increased oil and gas consumption. The UK has a legally binding target under the Kyoto 1 protocol to reduce its emissions of the basket 2 of six major greenhouse gases, and has announced its intention to put itself on a path towards a reduction in CO2 emissions of 80% by about 2050 [10].

Perhaps because GHG emissions can be more readily quantified than other impacts, they have attracted most attention from researchers and policy makers but GHG emissions are just one of a range of parameters that should be considered in assessing environmental impacts [11]. Others are ozone depletion, water consumption, toxicity, eutrophication of lakes and rivers, and resource depletion, and the aim of this paper is to review Life Cycle Assessment (LCA) as a means of evaluating the environmental impact of buildings [13].

1.1.1 Role of the Built Environment

Environmentally harmful activities differ from one industry to another, but it is well known that the biggest contributor to GHG emissions is the built environment, accounting for up to 50% of global carbon dioxide emissions. In addition, the embodied environmental impacts generated by the building during its whole life-cycle, can be of the same order of magnitude as those generated during the utilization stage. The building construction industry consumes 40% of the materials entering the global economy and generates 40–50% of the global output of GHG emissions and the agents of acid rain. The construction sector is responsible for a high percentage of the environmental impacts produced by the developed countries. In the European Union, the construction and building sector is responsible for roughly 40% of the overall environmental burden. Homes in the UK (their construction and occupation) are responsible for the consumption of 40% of primary energy in the country [3]. If the other 30% of the building stock (non-residential) is considered, the impact of buildings is greater. The construction industry is a highly active sector all over the world, and it is the largest industrial employer, accounting for 7% of total employment, and 28% of industrial employment. It is responsible for a high rate of energy consumption, environmental impact and resource depletion. Most European governments have introduced new policy instruments such as the European Community's energy performance directive for buildings (EPBD) in order to reduce the negative impacts from the building sector [4].

1.2 LIFE-CYCLE ASSESSMENT

There are many methods available for assessing the environmental impacts of materials and components within the building sector. While adequate to an extent for a particular purpose, they have disadvantages. LCA is a methodology for evaluating the environmental loads of processes and products during their whole life-cycle [5]. The assessment includes the entire life-cycle of a product, process, or system encompassing the extraction and processing of raw materials; manufacturing, transportation and distribution; use, reuse, maintenance, recycling and final disposal. LCA has become a widely used methodology, because of its integrated way of treating the framework, impact assessment and data quality. LCA methodology is based on ISO 14040 and consists of four distinct analytical steps: defining the goal and scope, creating the life-cycle inventory, assessing the impact and finally interpreting the results. Employed to its full, LCA examines environmental inputs and outputs related to a product or service life-cycle from cradle to grave, i.e., from raw material extraction, through manufacture, usage phase, reprocessing where needed, to final disposal [7].

ISO 14040 defines LCA as: "A technique for assessing the environmental aspects and potential impacts associated with a product, by: compiling an inventory of relevant inputs and outputs of a product system; evaluating the potential environmental impacts; and interpreting the results of the inventory analysis and impact assessment phases". LCA is often employed as an analytical decision support tool.‖. Historically it has found popular use comparing established ways of making and processing materials, for example comparing recycling with incineration as a waste management option. LCA is increasingly being seen as a tool for the delivery of more eco-efficient life-cycles [8].

1.2.1 Brief History of Life-cycle Assessment

The usage of life-cycle assessment as an environmental management tool started in the 1960s in different ways and under a variety of names. There is a confusing similarity between some of the terms that reflect different depths and types of study, especially in the literature of the early 1990s. The term life-cycle assessment has since been adopted to reflect environmental life-cycle studies. The origin of life-cycle thinking has been attributed to the US defense industry. It has been used to consider the operational and maintenance costs of systems. This has become a costing technique known as ―Life-Cycle Accounting‖ or ―Life-Cycle Costing. The first appearance of LCA in its current modern environmental understanding was in a study held by Coca-Cola to quantify the environmental effects of packaging from cradle to grave. The emphasis at that time was primarily on solid waste reduction, rather than on environmental emissions or energy use. The UK‗s first experience of the life-cycle perspective was published as a handbook of industrial energy analysis authorized by Boustead and Hancock. During that era many life-cycle studies had appeared followed by significant increase of public interest in the subject [9].

The Society of Environmental Toxicology and Chemistry (SETAC) held two LCA workshops during 1992. The first was on life-cycle impact assessment and the second concentrated on data quality. The North American and European SETAC LCA advisory groups met in Portugal 1993. And produced Guidelines for Life-cycle Assessment: A ―Code of Practice‖, sometimes referred to as the ―LCA Bible‖. Apart from SETAC work, some LCA guidelines which appeared during the 1990s include the publication of the Dutch guidelines on LCA. Authors from Nordic countries namely; Swedish, Finnish, Danish and Norwegian authors, published Nordic Guidelines on Life-cycle Assessment. The UN Environment Program published the Life-cycle Assessment: What Is and How to Do it, and The European Environment Agency‗s Life-cycle Assessment: A Guide to Approaches, Experiences and Information Sources. There were many initiatives to standardize the methodology of life-cycle assessment; the Canadian Standards Association released the world‗s first national LCA guideline Z-760 Environmental Life-cycle Assessment in 1994, to provide in-depth information on LCA methodology. But the most recognized standards were the ones published by the International Standards Organization ISO:

• ISO 14040 Environmental management, LCA, Principles and framework (1997).
• ISO 14041 Environmental management, LCA, Goal definition and inventory analysis (1998).
• ISO 14042 Environmental management, LCA, Life-cycle impact assessment (2000).
• ISO 14043 Environmental management, LCA, Life-cycle interpretation (2000).

1.2.2 The Need for Life-Cycle Assessment in Buildings

Although LCA has been widely used in the building sector since 1990, and is an important tool for assessing buildings, it is less developed than in other industries, including perhaps the engineering and infrastructure sector. The building industry, governments, designers and researchers of buildings are all affected by the trend of sustainable production and eco-green strategies. The importance of obtaining environment-related product information by LCA is broadly recognized, and LCA is one of the tools to help achieve sustainable building practices. Applying LCA in the building sector has become a distinct working area within LCA practice [10]. This is not only due to the complexity of buildings but also because of the following factors, which combine to make this sector unique in comparison to other complex products. First, buildings have long lifetimes, often more than 50 years, and it is difficult to predict the whole life-cycle from cradle-to-grave. Second, during its life span, the building may undergo many changes in its form and function, which can be as significant, or even more significant, than the original product. The ease with which changes can be made and the opportunity to minimize the environmental effects of changes are partly functions of the original design. Third, many of the environmental impacts of a building occur during its use. Proper design and material selection are critical to minimize those in-use environmental loads. Fourth, there are many stakeholders in the building industry. The designer, who makes the decisions about the final building or its required performance, does not produce the components, nor does he or she build the building [15]. Traditionally, each building is unique and is designed as such. There is very little standardization in whole building design, so new choices have to be made for each specific situation. The comparability of LCAs of distinct products and the way these LCAs are applied to design and construct environmentally sound buildings is a main point of attention in LCA practice. Several initiatives for harmonization and standardization of methodological developments and LCA practice in the building industry have taken place at a national level, but in general much scope remains for wider involvement and co-operation [16].

2. METHODOLOGY

2.1 INTRODUCTION

This Chapter deals with the scope of the project, objective of the project and methodology which explains the project stages in step by step.

2.2 OBJECTIVE OF THE PROJECT

This project work aims at the study of Life Cycle Assessment of the working labors for a small Residential Building and finding the alternatives for Noise creating Building Equipments.

2.3 SCOPE OF THE PROJECT

The Scope of this project includes:

1. Studies were made for different construction materials and equipment which creates environmental impacts.
2. To collect various information like building plan, activities, labour Requirement for each activity, area required to work per day and noise level of all construction equipment's.
3. To study the occupational hazards for all construction activities.
4. To take the report of affecting labours for each activity during the construction work.
5. Creating a Pie- Chart and rank the affecting percentage.
6. Develop an alternative solution for some of the construction equipment's and safety procedures.

3. DATA COLLECTION

3.1 SITE VISIT DATA'S

The following are the datum of the Residential Building collected from the site visit,

- Plan of the Building
- Activity Details
- Number of Labours required for each activity
- Quantity to be work by labours for each activity
- CO_2 Emissions of all building materials
- List of Occupational Hazards

3.2 HEALTH AND SAFETY HAZARDS IN THE CONSTRUCTION INDUSTRY

Construction workers build, repair, maintain, renovate, modify and demolish houses, office buildings, temples, factories, hospitals, roads, bridges, tunnels, stadiums, docks, airports and more. The International Labour Organization (ILO) classifies the construction industry as government and private-sector firms erecting buildings for habitation or for commercial purposes and public works such as roads, bridges, tunnels, dams or airports. In the United States and some other countries, construction workers also clean hazardous waste sites.

Construction as a proportion of gross domestic product varies widely in industrialized countries. It is about 4% of GDP in the United States, 6.5% in Germany and 17% in Japan. In most countries, employers have relatively few full-time employees. Many companies specialize in skilled trades—electricity, plumbing or tile setting, for instance—and work as subcontractors.

3.2.1 Construction Labour Force

A large portion of construction workers are unskilled labourers; others are classified in any of several skilled trades (see table 93.1). Construction workers include about 5 to 10% of the workforce in industrialized countries. Throughout the world, over 90% of construction workers are male. In some developing countries, the proportion of women is higher and they tend to be concentrated in unskilled occupations. In some countries, the work is left to migrant workers, and in others, the industry provides relatively well-paid employment and an avenue to financial security. For many, unskilled construction work is the entry into the paid labour force in construction or other industries.

3.2.2 Work Organization and Labour Instability

Construction projects, especially large ones, are complex and dynamic. Several employers may work on one site simultaneously, with the mix of contractors changing with the phases of the project; for example, the general contractor is present at all times, excavating contractors early, then carpenters, electricians and plumbers, followed by floor finishers, painters and landscapers. And as the work develops—for instance, as a building's walls are erected, as the weather changes or as a tunnel advances—the ambient conditions such as ventilation and temperature change too.

Construction workers typically are hired from project to project and may spend only a few weeks or months at any one project. There are consequences for both workers and work projects. Workers must make and remake productive and safe working relationships with other workers whom they may not know, and this may affect safety at the work site. And in the course of the year, construction workers may have several employers and less than full employment. They might work an average of only 1,500 hours in a year while workers in manufacturing, for example, are more likely to work regular 40 hour weeks and 2,000 hours per year. In order to make up for slack time, many construction workers have other jobs—and exposure to other health or safety hazards—outside of construction.

For a particular project, there is frequent change in the number of workers and the composition of the labour force at any one site. This change results both from the need for different skilled trades at different phases of a work project and from the high turnover of construction workers, particularly unskilled workers. At any one time, a project may include a large proportion of inexperienced, temporary and transient workers who may not be fluent in the common language. Although construction work often must be done in teams, it is difficult to develop effective, safe teamwork under such conditions.

Like the workforce, the universe of construction contractors is marked by high turnover and consists mainly of small operations. Of the 1.9 million construction contractors in the United States identified by the 1990 Census, only 28% had any full-time employees. Just 136,000 (7%) had 10 or more employees. The degree of contractor participation in trade organizations varies by country. In the United States, only about 10 to 15% of contractors participate; in some European countries, this proportion is higher but still involves less than half of contractors. This makes it difficult to identify contractors and inform them of their rights and responsibilities under pertinent health and safety or any other legislation or regulations.
As in some other industries, an increasing proportion of contractors in the United States and Europe consists of individual workers hired as independent contractors by prime- or sub-contractors who employ workers.

Ordinarily, an employing contractor does not provide subcontractors with health benefits, workers' compensation coverage, unemployment insurance, pension benefits or other benefits. Nor do prime contractors have any obligation to subcontractors under health and safety regulations; these regulations govern rights and responsibilities as they apply to their own employees. This arrangement gives some independence to individuals who contract for their services, but at the cost of removing a wide range of benefits. It also relieves employing contractors of the obligation to provide mandated benefits to individuals who are contractors. This private arrangement subverts public policy and has been successfully challenged in court, yet it persists and may become more of a problem for the health and safety of workers on the job, regardless of their employment relationship. The US Bureau of Labor Statistics (BLS) estimates that 9% of the US workforce is self-employed, but in construction as many as 25% of workers are self-employed independent contractors.

3.2.3 Health Hazards on Construction Sites

Construction workers are exposed to a wide variety of health hazards on the job. Exposure differs from trade to trade, from job to job, by the day, even by the hour. Exposure to any one hazard is typically intermittent and of short duration, but is likely to reoccur. A worker may not only encounter the primary hazards of his or her own job, but may also be exposed as a bystander to hazards produced by those who work nearby or upwind. This pattern of exposure is a consequence of having many employers with jobs of relatively short duration and working alongside workers in other trades that generate other hazards. The severity of each hazard depends on the concentration and duration of exposure for that particular job. Bystander exposures can be approximated if one knows the trade of workers nearby.

Each trade is listed below with an indication of the primary hazards to which a worker in that trade might be exposed. Exposure may occur to either supervisors or to wage earners. Hazards that are common to nearly all construction-heat, risk factors for musculoskeletal disorders and stress-are not listed.

The classifications of construction trades used here are those used in the United States. It includes the construction trades as classified in the Standard Occupational Classification system developed by the US Department of Commerce. This system classifies the trades by the principal skills inherent in the trade.

3. CONCLUSION

3.1 REPORT AND DISCUSSION

- This project deals with the Life Cycle Assessment of labours involved in the construction work of a small residential building of about 596 sq.ft. For this study, initially the details of the construction activities in step by step , the construction equipment and activities involved in construction which produces air, noise, water pollution are collected. A survey is made and the percentage of labours getting affected per day for all activities is calculated and a pie chart is drawn from the collected details. This Pie Chart clearly says that :
  1. the labours invovled in building works are getting minor hazards in their day to day life and the workers engaged in wood work are affected more i.e., 30% than the labours involved in other activities.
  2. if a certain percentage of labours getting affected from the above calculation for a small sq.ft as per the above plan , then let us assume the strategy of the labours will get affect if the area of the building doubles.

- The safety procedures and the controlling measures are studies from different sources and they are explained briefly in this project in order to prevent the labours from the hazards.

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