REFURBISHMENT OF OLD EXISTING BUILDINGS FOR ENERGY CONSERVATION

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SYNOPSIS

Motivation: *Expected life spans of building are generally decreasing due to the overall impact of climate change and reduced energy conservation capacity of the building components.*

Knowledge Gap: *Previous research have highlighted that the use of new and old materials for refurbishment without proper investigation can cause severe environmental health hazard to the occupants, and increased occupancy and operational costs. Hence, the need to investigate the compatibility of existing and new building materials used in the refurbishment of old buildings.*

Aim and objectives: *The aim of this study is to develop a guide to aid the selection of compatible building materials considering environmental health hazard, occupant comfort, and the long term cost effectiveness against the expected design life span of the building.*

Research method: *This study will investigate on the embodied energy of different building materials such as Polyvinyl Chloride (PVC), Fiber reinforced polymer (FRP) and light concrete against the conventionally used materials such as timber and steel in New Zealand. A case study method, comparying recently refurbished buildings in four selected regions in New Zealand will be conducted. First, the compatibility of new and old materials will be assessed. Second, the cost of energy in production, casting stage and life span of the building during its usage will be investigated. Lastly, a questionnaire survey from the building occupants to assess occupants' comfort will also be conducted. The research results will be analysed using simulation software.*

Preliminary or anticipated findings: *The findings may include recommendations on how to enhance conservation of energy and occupant's comfort, reduced health risk, and reduced building operational cost.*

Research significance: *The research findings would provide a clear understanding regarding the compatibility of older and newer materials to enhance building sustainability and energy conservation.*

KEYWORDS: Building refurbishment, Energy conservation, Building life span, Compatibility, Life cycle cost

INTRODUCTION

Energy conservation in old existing buildings can be improved by the application of different energy-saving measures and sustainable materials. These buildings require upgrade as a result of degradations and the impact of climatic change in the environment. Nowadays, climatic change is an urgent problem requiring immediate action. Therefore, old existing buildings should adapt to bioclimatic design through energy efficient refurbishment in order to improve their environmental performance and reduce the amount of energy they consume (DTI, 2003).

The use of these materials in refurbishment is essential if a building project is to be considered sustainable (Environmental Building News, 2001). Typically the construction industry enters the materials market at the point of selection and procurement, usually at the design stages. Before selecting a material, there are issues such as the energy conservation of the constituent materials, the compatibility of the materials with the existing ones, the cost effectiveness and the seismic resistance of each material need to be understood. The designers and project team members should be able to assess these factors with the design life span of the building. These will however help to deliver more sustainable projects that could minimize its environmental impact (Behzad Sodagar, 2013). Most studies had centered on the comparing embodied energy of constituent materials. However, the (Counsel for Research and Innovation in Building Research (CIB), 1999) state that significant issues of concerned for product manufacturing are: reducing the embodied amount of material and energy of the products. This includes renewable materials, low-energy recycling, increasing durability and technical life expectancy. Also, includes low emissions from products in use, repair ability and recyclability. Figure 1 demonstrates the embodied energy in a house by volume of material.

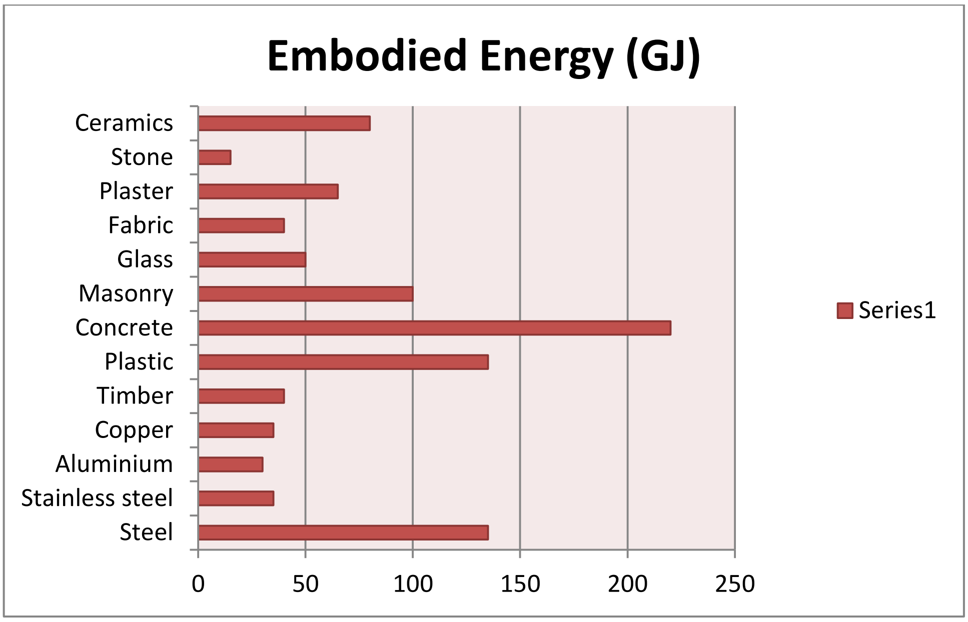

Figure 1: Embodied energy in a house by volume of material (Source: CSIRO, 2002)

One of the most critical factors in considering the environmental impacts of any material is the need to move beyond the material itself and more clearly understand its context, where and how it is used, maintained, abused, recovered or discarded and dumped, Green building Council Australia (2010). Too often, the environmental impact of materials could be addressed in isolation from their total content such that comparisons are made about 'material “X” being better than material Y.“ As true as it may be in some instances, there are ranges of other possibilities where the opposite could be just as true. Assessing materials without knowing or understanding their full life-cycle and environmental impact has the potential to result in a one dimensional outlook of how they might impact on the environment and therefore question their ultimate value of being specified in the first place (Centre For Design (CFD), 2002). However, the development of a sustainable built environment will largely rely on well informed building upgrade for existing infrastructure (Castleton et al, 2010). Cost effective materials with low embodied energy could be used to improve existing buildings (Jayasinghe Chinta, 2011). However, the compatibility issues with old materials, material recovery, expected life span of the building, long term cost effectiveness in simultaneous with climate change for a longer period need to be examined.

Overall, for a building to be sustainable, it should be constructed using locally sourced materials (Melia et al, 2014). Hence there is a need for an approach that lifts sustainable materials into a decision guideline for proper refurbishment. This, in turn, will improve occupant comfort, and the long term cost effectiveness against the expected design life span of the building.

RESEARCH AIM AND OBJECTIVES

The research seeks to provide answers to the following questions:

- What are the different sustainable building materials for building refurbishment available in New Zealand?
- What materials are best able to provide an increase to a building life span to meet clients' expectation?
- Are the installation procedures for these materials cost effectively and with reduced risk of implementation?
- Are the materials compatible, and energy conserving?

RESEARCH METHODS

This study will investigate on the embodied energy of different building materials such as Polyvinyl Chloride (PVC), Fiber reinforced polymer (FRP) and light concrete against the conventionally used materials such as timber and steel in New Zealand. A case study method, comparing recently refurbished buildings in four selected regions in New Zealand will be conducted. First, the compatibility of new and old materials will be assessed. Second, the cost of energy in production, casting stage and life span of the building during its usage will be investigated. Lastely, a questionnaire survey from the building occupants to assess occupants' comfort will also be conducted. The research results will be analysed using simulation software. A careful selection of eco-friendly may be the fastest way for builders to start integrating sustainable renovation concepts in old buildings.

ANTICIPATED FINDINGS

- The energy conservation capacity of refurbished buildings
- The emergy of sustainable building materials available in the community
- Analysis of refurbished home occupant satisfaction.
- Create awareness to construction sectors and clients on the cost, life span and new application approach for sustainable building materials.

RESEARCH SIGNIFICANCE

- Sustainable refurbishment gives clear advantages in cost, time, community impact, and avoidance of building degradation.
- It enhances the reuse of existing infrastructure and protection of existing communities.
- It also offers significant reduction in energy use of existing buildings for short and long term purposes.
- The life span of buildings is well protected when the materials are compatible

This study will provide recommendations that will enlighten the construction industry and the clients on the need to select suitable refurbishment materials on long term efficiency and cost for improving building sustainability. The industry will be able to understand and compare efficiency, cost effectiveness and expected life span of buildings with the emergy of PVC, FRP, concrete and that of timber and steel.

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