

# Investigation on the Role of Recycling Materials and the Importance of their Potential Energy in the Trend of Sustainable Development

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**ABSTRACT:** Recycling process is one of the most important processes in the trend of sustainable development, a logical reaction against the problems that results from industrial age. Building materials can play an important role in the process of a building formation or destruction, in fact, materials forms the building nature. Thus, the role of material and the impact of its recycling in sustainable development context cannot be ignored. Also, due to the rate of destruction and renewals that exist in cities and considering to the point that almost half of fuel storages are consumed in the buildings, the mass of materials that are sources of potential energy, should not be ignored. So, it is obvious that finding a fundamental solution in this area is necessary. In terms of research performance, this study is qualitative and as descriptive-comparative investigation and selection of the concepts is based on library and documentary methods, surveying some characteristics of recycling which in terms of quality and technique effect on architecture has been attempted in this research. Therefore, the role of recycling materials and the importance of their potential energy in the trend of sustainable development are investigated in this paper by descriptive-comparative method and appropriate and optimum solutions provided in order to reduce energy consumption in the field of construction and building materials.

**Keywords:** Recycling, Energy, Recycling Materials, Sustainable Development.

## INTRODUCTION

In the area of construction and subsequently destruction and renewal, a way should be found based on the principles of sustainable architecture to reduce consumption of materials and limited energy resources and increase the re-use of recyclable materials and optimum utilization of their potential energy. But today, despite of increasing the amount of constructions consequently, the destruction and renewal are greatly intensified. Due to use of combined materials, construction trashes are being increased daily and building materials that are potential energy resources discarded in the form of construction waste. Thus, construction issues should be seriously considered due to current technology and in addition to producing more environmental friendly materials, finding a way for decomposing buildings trashes and backing them in nature's cycle should be followed.

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## MATERIALS AND METHODS

This study is qualitative and as descriptive-comparative investigation and selection of the concepts is based on library and documentary methods. Surveying some characteristics of recycling in terms of quality and technique effect on architecture has been attempted in this research. Descriptive research seeks to describe the current status of an identified variable or phenomenon. The researcher does not usually begin with a hypothesis, but is likely to develop one after collecting data. Analysis and synthesis of the data provide the test of the hypothesis. Systematic collection of information requires careful selection of the units studied and measurement of each variable in order to demonstrate validity. Also causal-comparative/quasi-experimental research attempts to establish cause-effect relationships among the variables. These types of design are very similar to true experiments, but with some key differences. An independent variable is identified but not manipulated by the experimenter, and effects of the independent variable on the dependent variable are measured.

The researcher does not randomly assign groups and must use ones that are naturally formed or pre-existing groups. Identified control groups exposed to the treatment variable are studied and compared to groups who are not.

**RESULT AND DISCUSSION**  
**Life-Cycle Assessment (LCA)**

From the beginning of construction to the end of building destruction, LCA is used for evaluating the building effectiveness; it is a criterion to evaluate ecological values of materials such as energy or a product like brick than environmental criteria. LCA in a building is placed in the center of complex effects of construction, application and disposal processes. This tool has two major advantages: it can be used for leading engineers and helping managers in building lifetime, also, identifying the potential values of resources can be helped by reducing future legal problems or maintaining the building. In fact, LCA determines total life cycle cost and capital value (the actual construction cost) can be considered in the lifetime cost of a building, allowable cost, environmental value, maintenance, recycling and re-use, so, all of them to be regarded.(Brayan,2011)

**Recycling Potential**

In the energy as a single subject, the effect of a material dependent to initial costs of energy is called input costs and closing costs of energy called output costs. Energy is considered at the beginning and in building destruction again regarded. Two works are necessary to be done: first, ensure that potential of re-use and recycling influence on the choice of materials by designers at the beginning; second, ensure that the remaining energy to be extracted before transferring materials to landfill. The remaining energy may be generated electricity

by burning in a burn waste furnace or extracted through composition (material energy decompose to chemical products or by- products). Recycling take place when a material is re-used in the form of new product similar of the same material type. Generally, aluminum and copper can be both recycled with more than two third of all new copper compositions which are from old recycled coppers. The degree of recycling depends on product world price. Aluminum is usually cheap and very abundant and it is considered a barrier to recycling. On the other hand, copper is relatively expensive and there are significant limitations to provide world copper. So in fact, just 40% aluminum and 75%copper consumption is commonly recycled (Shunsaku, 2013)

**Comparison of embodied energy of building materials**

Embodied energy, an energy which is used for making and shaping a material and for evaluating potential weight/ strength of material and its ability is necessary to recycle the next materials.

Table 1: Comparison of embodied energy of building materials (Brayan,2011)

Construction Materials	Embodied energy (KWH/Tone)
Steel	7000
Aluminum	28000
Copper	1800
Wood (in use)	1000
Glass	2000

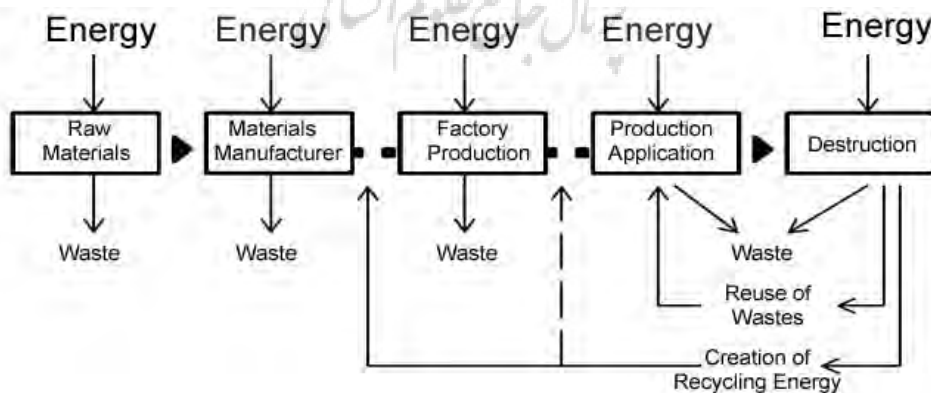


Fig. 1: The impact of a brick life cycle (Brayan, 2011)

## Recycling Materials

All buildings provide opportunities for recycling, re-use or waste reduction, some examples of high materials consuming are investigated in this paper.

### Steel

In steel foundry, structural steel either as a new structural member or as an old steel has an obvious advantage of re-use. Of course, used protective covering and installation method are important deterrent factors for recycling of steel. Aluminum also has similar advantages. All metals have high cost for construction energy and some have contaminated construction process.

### Concrete

Structural concrete offers another range of potential sources, concrete is very durable (if properly implemented), hence, concrete structures as structural skeleton are considered for recycling. Waste concrete results from structures destruction can be re crushed and used as aggregate in concrete construction. Using recycling concrete, environmental problems caused by concretes retail piled on the ground surface are reduced and also unsustainable extraction of natural stone aggregates prevented. Concrete does not usually need to polishing, so, it has fewer health risks and is also durable environmentally if the necessary climate benefits are added for other types of buildings. The experiments show that recycling concrete with more compressive and higher tensile strengths than ordinary concrete is achieved in most projects using micro silica and lubricants. Also, using local producing concrete products, the costs of energy used in transport will be reduced dramatically. Characteristics of recycled concrete:

1. Recycled crushed concrete has lower density and more porosity and consequently more water absorption than broken stone.
2. Replacing retail concrete instead of part or all of aggregate causes reduction in concrete specific weight.
3. Ultimate stress is for 25% of recycled concrete less than normal concrete which indicates a low modulus of elasticity of recycled concrete than normal concrete.
4. Based on the gained results, recycled concrete shows more shrinkage than normal concrete (Hajji Ghafari, 2003; Moghimi, 2010).

### Brick

Construction brick has a satisfactory appearance for a long-time and brick buildings are relatively healthy (no need to pay extra cost), they easily recycled at the end of their life and can be easily repaired in their longevity. If the building is destructed, the brick itself can be re used only if lime mortar (instead of cement) is attached. Brick can only be recycled as low value aggregate if mortar connection is strong, also recycled compositions can be used in brick production i.e. increasing a percentage of consuming waste paper in bricks, the porosity is

increased with the steady trend and the strengths and specific weight are decreased. Investigating the results and comparing them with the relevant standards indicate that produced bricks can be used in different parts of buildings, while the existed paper in brick composition due to heating value is effective on fuel cost saving at brickyard furnace (Bahrami, 2007; Institute of standard and industrial research of Iran 2009; 2010).

### Comparison of Steel and Concrete

The architects face with complex problem of testing steel to use in building while selecting building materials. The steel often seem less related to concrete because the consumed energy in its production is high and its heat capacity is low. Since steel can be recycled unlimitedly, the used energy in its production can exchange with the next generation but in fact steel may be a green wise choice however, concrete heat capacity is much considered (except in administrative buildings). Steel building for sustainability should be designed so that it can easily be assembled (Screw fitting not fusion) and have the same length in order to be reused.

### Chemical Recycling of Materials

In industrial world "re-conversion to material" refer to chemical recycling that increase material value and allows them to be repeatedly produced with high quality. This offers a design strategy with the goal of increasing positive effects of material and energy in materials cycles of abundance on the earth. For example, nylon is a good sample of "re-conversion to material". This very high consumption polymer can be chemically recycled and given raw material Caprolactam that very high quality fibers can be produced by it during very different cycles, in fact "re-conversion to material" offers a new model for materials flow which changes trading in the real worlds (Godford, 2004).

### Nanotechnology Research in the Field of Recycling

Now, building construction with native wastes or recycling material is made possible by nanotechnology researches have been done in the field of composites and waste and recycling management. These approaches have many applications to reduce significantly building construction cost especially in third world or developing countries. For example using natural fibers and industrial-agricultural wastes Indians have made roofing insulation. The Dutch have taken an important step in finding a material to satisfy heating needs of low-cost houses by creating an expandable shell and also one of the ways of applying nanotechnology in green buildings is using nonmaterial to prevent energy waste inside the building. For other application of nanotechnology in the field of building material, ticket cement is referred so that conducted tests indicate that adding nanoparticles, the disadvantages of this type of cement compatible with environment such as low initial resistance and long initial setting time can be removed

and it is a rival for ordinary Portland cement (Godford, 2004; Mahmoodi, 2008).

Also, because the inevitable issues such as drought, heat, direct radiation, erosion and dust are always in connection with optimal performance of building, and the rate of energy consumption is interesting and since nanotechnology are making progress in all dimensions and has affected all aspects of today's life. Among the applications of nanotechnology in architecture and some characteristics of it which in terms of quality and technology effect on building components and reduce the inflicted problems is totally could be mentioned: Effect of self-cleaning, air purifying, anti-fogginess, thermal insulation, temperature regulation, protection from UV radiation, sunlight protection, fireproof (Junbeum, 2013).

Engineers use four methods to reduce the production of constructional wastes:

Architects and engineers can design without generating the garbage and wastes. For example they use materials that do not need to cut in place. The application of standardized components and construction modular needs to change and thus reduce waste generation; in fact, architects should search a chain of certain wastes and also particular production.

Architects and engineers can use materials with capability to reuse, recycle or recover. Subtle use of elements, structural members and recyclable materials can reduce the costs but add to complexity of operations in building place.

Architects can design the buildings at the end of their lifetimes with the aim of assembly and simple dismantling, so, it is necessary to use materials with appropriate lifetimes. A full range of recyclable facilities with a more need to thinking will be created in designing by using screw connection instead of welded connection, wood screw instead of wood stud and lime instead of cement.

Architects can design buildings to be inherently flexible to reuse at the end of their lifetimes. Since, the structural life of a building is usually longer than economical life (100 years vs. 50 years), architects need to change the performance design.

Some solutions to avoid wasting materials:

Selection of recyclable materials;

Reducing the use of toxic and plastic materials in building to some possible extent;

Identification of materials (especially of being plastic) to determine their compositions;

Reduction to multiplicity and diversity of materials in a building;

Use of advanced manufacturing techniques and new materials in modular size, since the use of modular components not only prevents material waste but also has the advantage of easy "assemble" during construction and also easy "disassemble" in destruction;

Design and production of new material with a pre-anticipated approach to recycling category.

## CONCLUSION

The used materials in building construction have environmental impacts in the stages of extraction, preparation, transportation, application and disposal. These consequences in personal, regional and global scales influence on climate impacts and biodiversity and on the other hand on human health. Also one of the important technologies in current era is nanotechnology which has caused a huge development in all sectors, changes in the scale of Nano provide very high performance products; producing different construction products with very high-performance via nanotechnology causes saving money and energy and will be followed by more safety and welfare. Nanotechnology will play directly or indirectly an important role in producing appropriate materials with desired properties in different parts of the building and installations and the related cooling and heating equipment according to our needs and demands to reduce energy consumption.

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