



Management and Solutions for Reducing Environmental Pollution of Construction Wastes and their Recycling

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ABSTRACT

Management programs and recycling waste and construction debris can lead to increasing the productivity of materials in the construction industry and preventing environmental pollution if they are studied and implemented. Therefore, we have to consider the methods of recycling waste that has the least environmental problems. The important point in this regard is the assessment of the composition of materials and their constituent materials. Achieving this requires sequential sampling of existing urban spoils and then the statistical process on the results. Finally, for the use of these materials, it is necessary to determine the technical characteristics of these materials and determine the location and method of their use. Then, tests are carried out to investigate the chemical and hazardous materials that are brought to the landfill site along with waste and debris. In this regard, the design and implementation of waste management program and different methods of separation will be evaluated and its advantages and disadvantages will be investigated. Also, different methods for improving the recycling and optimization of solid waste will be examined.

Keywords: *Recycling, Management, Environmental pollution, Construction waste and debris*

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INTRODUCTION

Today, in most countries of the world, the issue of recycling and its environmental pollution and the necessity of this is not covered by anyone. Recycled materials include a wide range of urban and industrial waste or materials from the destruction of worn out buildings. One of the most important problems that has arisen in recent years in developed or developing countries is the massive build-up of debris. Due to the increasing value added of land and housing in the big cities and the focus of investment in this sector, cities have been developed and the old texture has been destroyed and replaced with new buildings, on the basis of which also the amount of construction waste has increased. Considering the increasing volume of urban waste materials and debris, including waste from the destruction of eroded buildings and the worn out texture of the city, especially in the big cities, and the numerous problems caused by the non-principled and non-technical use of these materials, the recycling of these materials is of great interest. Also, the rise in the cost of building materials in recent years and the need to increase productivity in the construction industry in the country has led employers and contractors to seek a way to reduce their development costs, and relevant organizations are seeking to

reduce the environmental impact of this construction waste. Management programs and recycling waste and construction debris can lead to increasing the productivity of materials in the construction industry and preventing

environmental pollution if they are studied and implemented. Considering the recycling of wastes is necessary for the following reasons:

- Environmental problems
- Landfill site
- Lack of raw materials
- Creating an inappropriate perspective
- Political and social issues

After determining the necessity and reasons for the recycling of rubble, the evaluation of the composition of the materials and their constituent materials. Achieving this requires successive sampling of existing urban spoils and then a statistical process on the results, but these results are highly dependent on the location of the surveys and the geographical and social conditions of the site. Finally, for the use of these materials, it is necessary to determine the technical characteristics of these materials as well as to determine the location and method of their use. To do this, it is possible to find useful ideas for the use of this material by examining similar work done in other parts of the world (Kriejger, P.C, 1981).

METHOD

In the following, the construction waste and debris should be tested for toxic and hazardous substances that are polluting the environment. Also, the destructive effects of the disposal of non-sanitary landfills on the environment, such as contamination of surface water and groundwater and soil, and diseases caused by the proliferation of insects in the area of

landfills due to unproductive and sanitary landfill will be investigated. Then, we study the recycling methods of building waste that leads to the least environmental problems and various tests, including resistance, wear, and... on recycled materials and reuse of recycled waste and production of new products such as: production of recycling aggregates for reuse, use in pavement layers, etc. (Zanjani M, 2006). We will also examine different methods to improve recycling and optimization of solid waste. In this regard, the design and implementation of waste management program and different methods of separation and its advantages and disadvantages will be evaluated.

1- Management

Management is the process of effective and efficient use of material and human resources in planning, organizing, mobilizing resources and facilities, guidance and control that is carried out to achieve organizational goals and on the basis of an accepted value system.

2- Management solutions to deal with building wastes

Regarding the management of waste and construction waste and planning for their organization, the following should be considered:

- Reduced waste production
- Recycle and reuse
- Disposal or burning

2-1- Decrease in production of construction waste

The most effective way to reduce the environmental impacts of building waste is to prevent the production of debris, reducing it to the extent possible. Therefore, reducing waste production will lead to economical savings and environmental protection. The high amount of rubbish means the extraction of more raw materials. On the other hand, the extraction and extraction of any materials from the environment with the destruction of the environment and environmental pollution (poon, C S. kou. S. C, 2002). To reduce waste production, the following are suggested:

- Planning to increase the lifespan of engineering structures
- Applying punitive policies for the destruction of new buildings
- Tax collection from waste producers

2-2- Recycling and reuse

The process of converting waste into reusable materials or energy is called recycling. Although structural debris has heterogeneous composition, it is possible to recycle a significant portion of these materials with proper management and re-enter the consumption cycle. Recycling as one of the strategies to minimize spoil has many benefits, including reducing demand for new materials and resources as a result of maintaining natural resources and raw materials, making optimal use of waste and consequent lack of landfilling and reducing costs of transportation and waste processing.

2-3- Landfill sites and construction waste disposal

Considering the increasing development of cities and the high volume of waste and debris, and the urgent need for depot or the burial or burning of such waste materials, finding the right place around the cities has always been a major problem for the authorities of the cities. Not only should these places have the slightest environmental problems, but also be far from the

center of the city, which would increase the costly transportation costs. The sites for disposal and burial of construction waste should be at least 300 m from the residential areas and ordinary roads, and 150 m from the surface of the rivers and rivers. The high volume of debris in cities and the cost of transporting to distant places has made it a landfill site that violates the law around towns. Determining the proper landfill should be carried out with the cooperation of various institutions and extensive studies have been done in this field that will have the least environmental impact on the climate and vegetation around the site of disposal.



Figure 1. The location of waste discharge and construction debris

3-History of construction waste management plan and its recycling

The use of brick, plaster, sand, gravel, and gypsum in the construction industry in Iran has a long history, so that the use of brick barriers for buildings of more than one floor and even up to four floors has been commonplace up until recently. The same use of brick and gypsum and... for the roof system, which is known for its protrusion, is the most common type of roof in Iran. Therefore, it can be expected that the brick has the largest share in the construction waste. Sand-cement mortar (or concrete) is also a material that has a high proportion in the common rubbish in Iran in recent years. With the establishment of the Construction Waste and Debris Management Section, which is affiliated with the Municipal Recovery Organization of each province, management is organized in three phases of collection, transportation and disposal. For each of these steps, programs have been implemented and additional programs will be implemented in the future. In the future, the waste is to be transported to separate locations after collection, and then recovery operations are carried out.

The use of recycled materials has become increasingly prevalent in most developing and industrialized countries. For example, there has been a lot of research on how to use building waste, and certain standards have been developed for using this material in Germany, the Netherlands, Belgium and Norway Hendriks, Ch. F.)

4-The necessity of recycling construction waste

Generally, the production of any waste, including dry waste, wet waste, hospital waste, or construction waste, threatens the environment and the health of the human race; especially if the disposal of such waste is unhealthy and non-hazardous, environmental and health problems will be twice as likely and sometimes irreversible. The pouring of these materials into unauthorized places over time causes the harmful substances in the debris to enter the water cycle of the earth's interior, and it is possible to eliminate natural vegetation in the disposal areas, to change the topography of the site, and to dispose of these materials in close proximity of the people's place of residence will prevail in various diseases, including the

leishmaniosis, and most importantly, the damage to the landscape and the aesthetic aspects of the environment. Therefore, due to environmental and health reasons, lack of primary materials and their high prices, as well as economic, cultural or political problems, and the development of various diseases and complications of pollution, the reduction of the amount of waste produced, and in particular the recovery, even a small portion of it and returning it to the consumption cycle, as well as reducing destructive and environmental impacts, is one of the most important concerns of today's societies and has brought the attention of officials and specialists. In general, a large proportion of waste produced in large cities can be divided into four groups:

- A) Wet waste
- B) Dry waste
- C) Hospital waste
- (D) Residues from the destruction of buildings

One of the most massive types of waste, debris resulting from the destruction of buildings, roads and structures is available. According to the statistics, the volume of construction waste produced in Tehran during one day is 5 times the amount of urban waste, which is a very significant amount. If not recycled, these materials will allocate the highest volume and space of disposal and burial places around cities.

- 1) The city of Mashhad has more than a thousand year old texture along with new textures. The city, which is the second largest metropolitan of the world, receives more than 20 million travelers and pilgrims from all over Iran and other countries annually in view of the holy shrine of the eighth Imam of the Shiites of the world. The development of the city, as well as the replacement of the old texture and the construction of new buildings, have led to the destruction of the old texture and resulted in the production of building strings with a volume of more than 1 million tons in recent years. Table 1 shows the data of one of the sampling carried out by the researcher on the type and percentage of debris from the landfill sites and also Figure 2 shows the amounts of debris and debris discharged at the burial site in the Mashhad: (Sources of Information and Statistics of Mashhad Health Center, 2009 and 2010)

Table 1- Mechanical properties of sampled debris

Sample Weight (Kg)	Passed from sieve (20 mm)		Residue on sieve (20 mm)		Brick	Cement mortar and concrete	Plaster and gypsum plaster	Rock	Tile and Ceramic	Asphalt and bitumen sack	other items
	Weight (Kg)	23.9	Weight (Kg)	26.1							
50	Volume (m ³)	0.017	Volume (m ³)	0.0243	0.0053	0.0079	0.0098	0.0008	0.0004	-	-
	Percent (%)	47.8	Percent (%)	52.2	13.8	19.3	16.5	1.8	0.4	-	-
	Special Weight (gr/cm ³)	1.4	Special Weight (gr/cm ³)	1.07	1.3	1.23	0.85	1.2	0.5	-	-

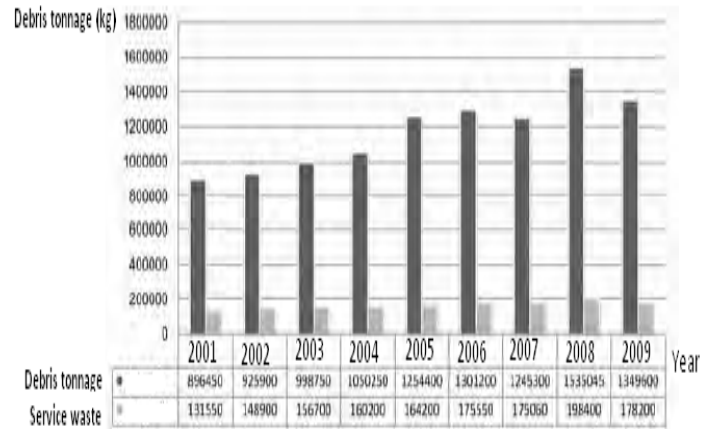


Figure 2. Frequency diagram of soil and debris evacuation changes at landfills in Mashhad

[Mashhad Recycling Information & Statistics Center]

By examining the depleted wastes in the landfills in Mashhad and obtaining the type and amount of waste that are commonly found in the weeks and months of the year, accurate and correct planning can be made in the field of executive recycling of Mashhad and other large metropolises in the same manner.



Figure 3. Mechanized system for collecting waste and urban waste

4-1- Leishmaniosis

- 1) Leishmaniosis is one of the diseases directly related to soil and construction waste which either dry (urban type) or wet (rural type) exists. Leishmaniosis is an infectious skin disease that lesions improved after one year, but the scars remain. The causative agent of leishmaniosis is a single-cell organism that lives in the body of stray dogs and mice living in unauthorized landfills or drainage sites for construction waste and debris, which is the most suitable place for their growth and reproduction. A tiny mosquito called sandfly bites them and the parasite enters the body. This small mosquito, which does not have a lot of flying, brings Leishmania into a person's skin and creates leishmaniosis. The inadequacy of environmental health measures and municipalities regarding the collection of waste and scum, which significantly increases the number of carriers of the disease

which Figure (4) shows the percentage of incidence of the leishmaniosis and its number in recent years in Iran: (Statistical sources of the organization of recycling and organization of building waste of Mashhad city, 2009 and 2010).

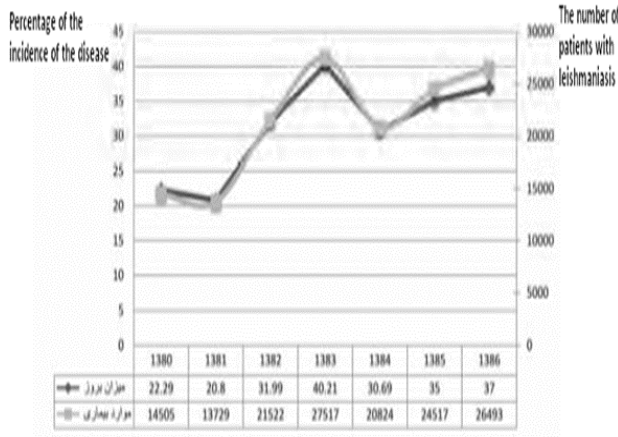


Figure 4. The pathogenesis of leishmaniosis in Iran during 2001 to 2007

[Mashhad Health Statistics Center]



Figure 5. Skin lesions caused by leishmaniosis

5- Characteristics of building waste

The source of construction waste is the following:

- Debris from demolition of old buildings
- Debris from ground excavation
- Waste from construction and surplus and unusable materials
- waste of roads, construction of sidewalks, bridges, etc.
- The foliage of the trees

And also the material of construction waste can be divided into the following:

- Concrete, brick, tile, ceramic and materials made of plaster and asbestos
- Soil and rock
- Metals, wires and cables

- Wood, glass, plastic and polyethylene materials
- Soluble materials
- Asphalt and other products of bitumen

6- Factors affecting the properties of building waste

In order to plan and manage as much detail as possible on building waste, the following factors should be considered as factors affecting their properties:

- 1) Type of structure: road, bridge, residential building, commercial and industrial
- 2) Structural Dimensions: High or low elevation, apartment or villa
- 3) Type of activity: construction, reconstruction, repair or demolition
- 4) Overall dimensions of the project: mass or single
- 5) Project location: Urban or rural, inland or coastal
- 6) Type of materials used: brick, concrete, wood and...
- 7) Destruction method: hand or machine, use of explosives
- 8) Damage speed: fast or slow

7- Recycling of various construction waste

Recycling is the first priority in waste management, which if done well, we will have 80 to 90% reduction in volume. In the recyclable system, the sales of products create a revenue-generating method, and the recycling process is shorter than the process of producing similar materials, which is more cost effective than recycled waste products. Recycling of construction waste has many advantages as follows (Kasaai, et al):

- Preservation of resources and energy
- Reducing environmental pollution
- Reducing the volume of exhaust fumes
- Economical economy

7-1- Recycling concrete and reuse it

Crushing non-reinforced concrete and using as filler material or material with materials for re-supplying concrete and concrete pieces of a large size for damming along the river as well as road infrastructure, land filling and leveling..

7-2- Non-concrete rubbish recycling and reuse of them

As far as possible, non-concrete masonry debris should be separated from concrete. In the event of mixing, the cost of separation is high. They are crushed as granular road pavement with asphalt.

8- Construction waste recycling process

- 1) Determination of the quantity of waste and its types in the pre-degradation or waste production stage.
- 2) Artificial destruction of the structure.
- 3) Primary collection and separation.
- 4) Transportation of construction waste
- 5) Temporary storage and secondary separation
- 5) Recovery and disposal of construction waste that is no longer usable.

9- Construction waste separation methods

- In the place of production (simply, mainly manually): The method of separation at the source has many advantages, including higher speed of recycling, less recycling costs and...

- In the temporary storage: Separation method at the temporary site, less cost to carry and recycle more easily at the final location.

- In the recycling facilities (more sophisticated equipment): Mixed separation method increases recovery time associated with more costs.



Figure 5. Mechanical separation of construction waste

10-Different techniques and equipment for separation

Different methods are proposed for isolating waste and building materials, as follows:

- 1) Manual separation
- 2) milling machine
- 3) magnetic separator: for iron
- 4) wind separation: for removing light particles
- 5) dusting separation: hoods, filters, cyclones
- 6) launch separation: according to the weight and size of the movement
- 7) Separation with fluid: by washing with water or settling and immersion in a fluid
- 8) Screen (sieve): To separate the crushed material with desired dimensions, such as shaking cylinder and rotary cylinder.
- 9) Electronic separation. Use of this science to detect particle size, detection of iron and non-ferrous metals, and determination of the color of the objects.
- 11) Re-heating: In order to separate the mortar with non-concrete rubble (bricks) as well as recycle old bricks (several years old)

11- Comparison of raw materials with recycled materials

The difference of recycled materials with their counterparts (raw materials) is expressed as follows:

- Size: Having more inconsistent and more unusual shapes than the original
- Density: Recyclable materials have a lower density.

Water absorption: Water absorption is higher in recycled materials

- Durability: According to the experiments carried out under conditions below the melting point and freezing of recycled materials are more durable.

12-The most important sources of pollution in building constructions

The main sources of toxic and chemical pollutions in construction waste and debris that result in high environmental pollution in cities and landfills are presented in Table 2 below:

Table 2- Sources of possible pollutions of construction waste and debris

Type of material	Possible contamination	Type of material	Possible contamination
Natural stones	Heavy metals	Plastic	Phenol, organic compounds CHx
Plaster	Sulfate, heavy metals	Dam materials	PCP
Asbestos	Asbestos	Dust	Heavy metals
Wood equipment	Heavy metals, phenol, PCP	Acids	Alkaline, oil, acid
Valves and sanitary equipment	Heavy metals, mercury, cadmium	Anti-fire devices	PCDF, PAH, PCDD

CONCLUSION

Construction waste make up the bulk of solid urban waste that requires proper management. The most important issue is waste transport and disposal of them. The large amount of waste produced will require a large amount of space for transportation and disposal. The volume of construction waste is dependent on factors such as the population growth rate and the increasing need for new housing, the rate of migration of villagers to cities, the structure of existing buildings and the architecture of existing buildings and the demands of the present generation which the necessary coordination and cooperation between the different organs of the municipality in the organization of construction waste should be carried out. There should be a special occupation to carry construction waste in the organization. Although construction waste has already been identified as safe and inert compared to waste, hazardous waste with debris and inappropriate landfill have created hazards for the environment and humans from the early 1990s, according to conducted studies. And in order to meet the needs of citizens, today we witness the construction and implementation of various development projects in large cities that the implementation of these projects leads to the production of large quantities of soil and building waste. Considering that many of these wastes have been discharged unpredictably around the city in the past, and nowadays after the development of cities, many buildings have been created on or near these wastes and caused many structural and environmental problems that we will fix the arisen problems as much as possible with proper management and the construction of standard landfills and recycling centers around the cities.

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