

SUSTAINABLE GUIDELINES FOR MANAGING DEMOLITION WASTE IN EGYPT

Marwa S. Al-Ansary ⁽¹⁾, **Salah M. El-Haggar** ⁽²⁾ and **Mahmoud A.Taha** ⁽³⁾

(1) Engineering Department, Cambridge University, United Kingdom

(2) Engineering Department, the American University in Cairo (AUC), Egypt

(3) Engineering Department, Construction Management Program, Cairo University, Egypt

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Author contacts

Authors	E-Mail	Fax	Postal address
<u>Marwa S. Al-Ansary</u>	msma3@cam.ac.uk	+441223339713	Engineering Department, Cambridge University, Trumpington St., Cambridge CB2 1PZ, United Kingdom
Salah M. Al-Haggar	elhaggar@aucegypt.edu	+202 795 7565	Mechanical Engineering Department, The American University in Cairo, P.O. Box 2511, Cairo, Egypt
Mahmoud A. Taha	mahmoud_taha99@hotmail.com		Structural Engineering Department, Construction Management Program, Cairo University, Cairo, Egypt

Contact person for the paper: Marwa S. Al-Ansary

Presenter of the paper during the Conference: Marwa S. Al-Ansary

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Marwa S. Al-Ansary (1), Salah M. El-Hagggar (2) and Mahmoud A. Taha (3)

(1) Engineering Department, Cambridge University, United Kingdom

(2) Engineering Department, the American University in Cairo (AUC), Egypt

(3) Engineering Department, Construction Management Program, Cairo University, Egypt

Abstract

Demolition activities, including renovation/remodelling works and complete or selective removal/demolishing of existing structures either by man-made processes or by natural disasters, create an extensive amount of wastes. These demolition wastes are characterised as heterogeneous mixtures of building materials that are usually contaminated with chemicals and dirt. In developing countries, it is estimated that demolition wastes comprise 20% to 30% of the total annual solid wastes. In Egypt, the daily quantity of construction and demolition (C&D) waste has been estimated as 10,000 tonnes. That is equivalent to one third of the total daily municipal solid wastes generated per day in Egypt.

The objective of this paper is to recommend practical guidelines to be added to the Egyptian Executive Regulations 338/1995 of the Egyptian Environmental Law no. 4/1994 to manage the amount and types of demolition waste in Egypt. These guidelines were scientifically tailored and were based on the responses from 35 Egyptian construction companies regarding how construction waste is handled on their projects, and from 40 samples of people with different backgrounds on ways to reduce the disposal of building materials waste in Egypt. The proposed guidelines were evaluated by a number of prominent national and multinational construction organisations in Egypt.

This paper summarises the proposed Egyptian demolition waste management guidelines, which cover: (1) the waste management hierarchy based on the '4Rs' Golden Rule of Reducing, Reusing, Recycling and Recovering of waste; (2) the different implementation stages which start from the early planning phase, followed by the tendering and contract formulation phase and finally the execution phase; (3) the various techniques, methodologies, procedures and strategies recommended to reduce the amount of waste and (4) the degree of involvement of all the construction industry parties (owner, engineer, designer, and contractor) in the implementation of the guidelines.

Keywords: Building materials waste, sustainability, demolition waste, Egypt, waste management, waste plan.

1. INTRODUCTION

The sustainability paradigm has become one of the global concerns since the UN summit on Environmental and Development in 1972, the World Commission on Environment and Development in 1987 and the UN "Earth Summit" in Rio de Janeiro in 1992 [1]. Consequently, the introduction of the 'triple bottom line' of sustainable economic, environmental and social targets into the construction industry, known as 'sustainable construction', has become a major concern.

One of the main obstacles for achieving sustainable construction goals is the generation of vast amounts of building materials wastes resulting from the construction and demolition activities. Managing wastes generated from construction activities, i.e. construction wastes, has been covered in a previous paper written by the authors [2]. This paper will concentrate on wastes generated from demolition activities known as 'demolition wastes'.

Demolition wastes are heterogeneous mixtures of building materials such as aggregate, concrete, wood, paper, metal, insulation, glass that are usually contaminated with paints, fasteners, adhesives, wall coverings, insulation materials, and dirt. These types of wastes are generated from the complete or selective removal/demolition of existing structures either by man-made processes or by natural disasters such as earthquakes, floods, hurricanes, etc. [3]. In addition to wastes generated from renovation and remodelling works.

The composition and quantities of demolition wastes depend on the type of structure being demolished, the types of building materials used, and the age of structure being demolished. The most common types of wastes generated from demolition activities are wood, rubble, aggregates, ceramics, metals and paper products. Although there is no typical percentage of each waste stream generated from demolition activities, the quantity of demolition wastes from residential buildings is estimated to be 1.3 to 1.6 ton/m² of the ground floor area of the structure. The quantity of demolition wastes resulting from industrial structures is estimated to be from 1.5 to 2.0 ton/m² of the total demolished area [4]. In general, demolition wastes are estimated to be from 1.0 to 2.0 ton/m² of the total ground level area.

In developing countries, demolition wastes comprise 20 to 30% of total annual solid wastes [4]. In Egypt, the quantity of construction and demolition (C&D) wastes has been estimated as 10,000 tonnes per day (approximately 4.5 million tonnes annually). That is equivalent to one third of the total solid wastes generated per day in Egypt [5]. On the other hand, the annual production rate of construction and demolition waste from the whole planet is around three billion tonnes [6]. In Egypt, demolition activities are carried out by conventional demolition methods. Advanced demolition techniques, i.e. by using explosive materials, are not commonly used in Egypt.

2. DEMOLITION WASTE MANAGEMENT

Various endeavours have been attempted to manage the wastes generated from demolition activities. For example, grinding of demolition wastes has been attempted to reduce the total waste volume while the resulted powdered wastes could be landfilled [7]. However, preventing the generation of demolition wastes is more effective waste-management technique.

There are many advantages in managing demolition wastes, such as reducing air-borne pollutants generated from unloading activities of waste, decreasing the possibility of heavy metals and hazardous constituents within the waste stream that could possibly contaminate both soil and underground water, improving health and safety conditions by controlling hazardous materials, broken and sharp objects and leachates from biodegradable wastes

within the waste stream, and minimising visual pollution that negatively affects socioeconomic development in Egypt.

This paper proposes comprehensive and practical waste management guidelines that will reduce demolition waste by utilising conservation and waste management schemes. The core of these proposed guidelines is to implement the sustainable development objectives by minimizing the quantity and environmental hazard of wastes; conserving the exploitation of virgin materials; and generating profits and work opportunities.

The proposed guidelines have three main characteristics: (1) compatibility with the Egyptian code of practice, (2) generality to be tailored to any demolition project depending on its uniqueness of circumstances, type of contract and nature of its activities, and (3) practicability of the suggested options and alternatives. The guidelines are applied through the planning stage to the demolition phase. The recommended guidelines cover various techniques, methodologies, procedures and strategies in mitigating the generation of wastes with regard to Egypt's own situation and circumstances. Furthermore, the waste management strategy will be examined from the project participants' perspectives i.e. owner, engineer, designer, contractors, suppliers, and subcontractors.

3. PROVISIONS IN THE EGYPTIAN ENVIRONMENTAL LAW [8]

The Egyptian environmental legislator has regulated the dumping and treatment of solid wastes including demolition wastes. The Egyptian Environmental law No. 4 passed in 1994 has defined and regulated the dumping and treatment of solid wastes in many provisions. In chapter (1) of this law, General Provisions, Article (1) No.13, polluting materials and factors have been defined.

Dumping and transporting procedures of the solid wastes especially demolition waste are regulated in Part II, Article 39 and Article 41 in the Egyptian executive regulations 338/1995. Article 41 states means for safe sorting and transporting of these wastes to prevent any wafting and flying, as follows: "(1) Stacking the wastes on the site shall take place in a safe manner away from any impediment to traffic and pedestrians movement. Wastes liable to volatilize in the air shall be covered to avoid causing pollution to air, (2) Wastes materials and earth resulting from digging, demolishing and building works shall be transported in special containers or receptacles by using trucks that are provided and licensed for this purpose, and fulfilling the following conditions: (a) The trucks shall be fitted with a special box or tight cover to prevent the spread of dusts, earth, and waste materials in the air, or their falling off on the road, (b) The truck shall be provided with special equipment for loading and unloading, and (c) The truck shall be in good condition fulfilling the rules of safety, solidness, and lights, and shall be fitted with all safety equipment, (3) The places appropriated for receiving these transported wastes shall be lying at a distance of not less than 1.5 kilometres from the dwelling zones, and at a lower contour level. They shall also be levelled after filling them completely with the wastes, and (4) The localities shall determine the places to which the wastes shall be carried to. These wastes shall not be authorized for transport or getting rid of them except at the places licensed for the purpose by the competent Authority and appropriated for such needs."

Although, Article 37 had prohibited throwing of any solid wastes except in licensed places that are away from dwelling, industrial, and agricultural areas and the watercourses, there are many illegal dumping of demolition wastes on public roads, highways and besides residential areas. Moreover, the penalty of throwing of solid wastes stated in Article 87 was a fine of not less than one thousand Egyptian pounds and not exceeding twenty thousands pounds for all violators.

4. DESIGN AND RESEARCH METHODOLOGY

Even though the Egyptian Environmental Law regulated the disposal of demolition wastes, the law did not include any clauses that suggest waste minimisation. The objective of this paper is to recommend practical guidelines to be added to the Egyptian Executive Regulations 338/1995 of the Egyptian Environmental Law no. 4/1994 to manage the amount and types of demolition waste in Egypt [3]. These guidelines were scientifically tailored and were based on the responses from 35 Egyptian construction companies regarding how construction waste is handled on their projects, and from 40 samples of people with different backgrounds on ways to reduce the disposal of building materials waste in Egypt. In summary, the guidelines were designed based on conclusions inferred from two instructed surveys and published literature, and were then reviewed by selected participants. Subsequently the guidelines were upgraded based on the evaluation by a number of prominent national and multinational construction organisations in Egypt.

The design of the recommended guidelines was based on a planned research methodology that was executed through four stages, as fully described in [2] and [3]:

The *first stage* investigated public opinion regarding (i) the waste problem in Egypt, (ii) the current practice of waste management in the Egyptian construction industry and (iii) the extent of awareness among practitioners. This was fulfilled through two types of instructed surveys/questionnaires. Afterwards, data obtained from the questionnaires was statistically and analytically examined by establishing a confidence limit of 95%. Conclusions were inferred from the participants' responses and served to ascertain the limitations of implementing the proposed guidelines in the Egyptian construction industry.

The *second stage* extensively researched both national and international literature regarding alternative technologies, techniques, methodologies and strategies used in mitigating the problem of demolition waste. In this stage, the practical requirements for the guidelines were clearly identified in lieu of the conclusions inferred from the surveys.

The *third stage* tailored the guidelines in order to be practical and compatible in the Egyptian construction context. The proposed guidelines were designed based on the waste management hierarchy of the 4Rs Golden Rule [5] as shown in Figure 1.

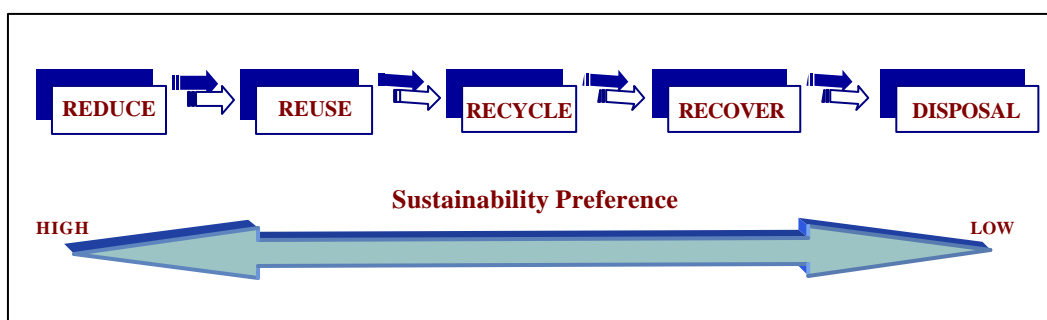


Figure 1: 4Rs Golden Rule of waste management hierarchy

Since the sustainability preference of the 4Rs Golden Rule is from right to left; source reduction techniques were more favourable in the proposed guidelines followed by reusing, recycling, and then recovering. Consequently, the undesirable option of waste disposal could be possibly eradicated as a management option. The 4Rs Golden Rule strategies were employed throughout the various stages of a demolition project, from the early planning to the

execution phases. The 4Rs Golden Rule techniques offered a number of waste management alternatives and identified the roles and responsibilities of the project's different participants.

The *fourth stage* validated the proposed guidelines through a feedback process. This process was accomplished by distributing the guidelines among construction specialists, with predetermined selection criteria based on the respondent's area of speciality and years of construction experience. The specialists had evaluated and assessed the practicability and feasibility of implementing the guidelines in Egyptian demolition projects; accordingly the guidelines were improved and upgraded.

5. PROPOSED DEMOLITION WASTE MANAGEMENT GUIDELINES

The proposed waste management guidelines consist of five main sections: Reduce, Reuse, Recycle, and Recover and Disposal. Each section exhibits strategies and roles for each member of the project team to mitigate the generated demolition waste.

5.1 Reduce technique

Reduce is a precautionary technique aimed at minimising the waste generated from the source before it becomes a physical problem. The reduce technique could be employed in the planning, tender and contract formulation and execution phases as follows:

5.1.1 During the planning phase

During this phase the main participants are the Owner and the Engineer, i.e. the Owner's team. It is recommended during this phase that the Owner's team should choose a selective demolition technique instead of complete demolition/removal of structure whenever possible. In that case some of the installations such as walls and ceilings can be retained while the interior systems of the structure can be renovated.

5.1.2 During the tender and contract formulation phase

During this phase the main participants are (i) the Owner's team and (ii) the Contractor's team. The recommended roles for both teams are:

(i) The Owner's team's responsibilities could be:

- The Owner has to assign an "Engineer" to act as his consultant to provide the required professional and technical expertise in managing the demolition course of works.
- The Owner/Engineer should avoid evaluating the contractor's bid on the lowest price but should evaluate it instead on the lowest responsible bid in which prior experience in carrying out the demolition works safely and with maximum recovery of materials is taken into consideration. The contractor should include the associated costs of implementing the waste management plan in the price quotation. If the contractor fails to submit the waste management plan within the tender/bid documents, the contractor should be held irresponsible, and should hence be disqualified.
- The Owner/Engineer should assure that the waste management plan is enforceable in the contract, possibly by means of a binding clause in the contract tendering documents.
- The content of the clause could be:

"The owner desires that as many materials as possible from this project be recovered and recycled to minimize the impact of demolition waste on the surrounding environment and to reduce the expenditures of energy and cost in fabricating new materials. To this end, Contractor shall submit a waste management plan showing the separation and mitigation actions for each material in the waste stream- generated as part or full from demolition of the buildings, pavement, vegetation, utilities and any

other works associated with the contract scope of work - within the bidding documents. The mitigation actions should be planned to maximize the amount of reuse, recycle and recovery of wastes and to minimize the amount of wastes to be disposed. The waste management plan shall be part of the tender evaluation. If the contract is awarded, it will be the Contractor's duty to implement and abide by the waste management plan. Failure to do so will constitute a breach of contract on the part of the Contractor."

(ii) The Contractor's team's responsibilities could be:

The contractor should prepare a draft of demolition plan. The plan should include a summary/brief of the following:

- An estimated time-frame to fulfil the goals of the waste management plan.
- The sequences of carrying out demolition works, such as: demolition, segregation, loading, hauling, crushing, consolidation and then stockpiling materials on site.
- A survey of the building materials that could be reused, recycled and recovered throughout the project- by type and quantity.
- The quantities of disposed materials.
- The quantities of each waste stream generated by the project. The quantities could be estimated based on either data compiled from previous projects or from experience with similar types of projects.
- Identification of any hazardous materials and means of proper disposal.
- The on-site separation/sorting strategies to segregate recyclables from other waste materials.
- A list of all on-site recycling techniques.
- Name and address of licensed disposal facilities accepting the generated waste materials.

5.1.3 During the execution phase

During this phase, the main participants are (i) the Owner's team and (ii) the Contractor's team. Their recommended roles and responsibilities are as follows:

(i) The Owner's team's responsibilities could be:

- The Owner/Engineer should provide stringent site supervision upon the Contractor's site works to ensure proper implementation of waste management tactics.
- The Owner's team should supervise the contractor's performance in implementing the waste management procedures, and taking corrective actions when needed.
- The Owner's team should establish criteria to evaluate the contractor's performance. Possible criteria could be visual inspection checklists.

(ii) The Contractor's team's responsibilities could be:

- After the receipt of Notice of Award to Bid, by a maximum period designated by the Owner, the Contractor should submit a full detailed waste management plan.
- The contractor should plan the demolition sequence in advance generating the least amount of wastes while maximising reduce, reuse and recover endeavours.

5.2 Reuse techniques

The reuse technique is defined as re-employment of materials to be reused in the same application or to be used in lower grade applications. The Contractor has the major

responsibility in adopting the reuse techniques in the project through the execution phase, as follows:

(A) Collection procedures

- Separation/segregation/sorting techniques should be implemented to the waste stream.
- Labelled containers for each waste stream and schedule of the pick-up times of the containers should be provided.
- On-site storage areas to dump the containers should be designated. In order to prolong the waste life and extend the reusable abilities, the storage areas should be: (1) remote enough from the site to limit the access to the stored material and hence control its contamination; (2) labelled by large signage to describe the purpose of the area and (3) protected from the weathering conditions, such as rain and dust.

(B) Waste management personnel

A waste management team should be assigned to accomplish the tasks needed for this activity. The team could consist of a waste manager and a group of trained labourers. The task of the waste manager could be:

- Setting up the waste management program.
- Supervising the waste separation and sorting activities.
- Supervising the reuse of waste as per the contractor's waste plan.
- Supervising the waste preparation to be transported to recyclers.
- Supervising the legal disposal of wastes.
- Instructing and supervising the work of the trained labourers.
- Monitoring the wastes periodically to prevent any mixing or contamination.

(C) Work activities

- The sequence of demolition activity shall start by removing any valuable materials such as doors, windows, hardwoods or flooring prior to demolition activity that could be reused, recovered or salvaged. Afterwards, the building interior should be demolished manually, followed by demolition of the core of the structure using heavy equipment. Then excavators could be used to sort and compact recyclable and salvaged materials on site.
- Salvaged/recovered materials could be used in same or in other applications as fully described in [2]. Such materials include: wood, earth works, plastics, vinyl, foam, steel, concrete, masonry (e.g. blocks and bricks), tiles (e.g. ceramics, marble and granite), plasterboard, insulation materials, paints, solvents and carpets.
- The Contractor should designate a secure and safe storage area for recovered and salvaged wastes to avoid any loss or damage that may occur to these materials.

(D) Documentation

- The Contractor should record and control all the waste management procedures documents.
- The Contractor should periodically update the data in his registers in order to prove or disprove the adequacy of the selected management techniques during the project execution phase.
- The Contractor should track costs or profits associated with various waste management methods.

- The Contractor should develop learning curves to update the labourer's abilities in implementing waste management techniques.
- The Contractor should document all methods and techniques of mitigating the waste, quantities and types of generated wastes experienced through the completion of project.
- The Contractor should submit within the progress of payment application, a summary sheet describing all reduce, reuse, recycle, recovery and legal disposal of wastes. This summary should be supported by proper documentation. Table (1) is an example of a summary sheet.

Table 1: Waste management plan summary sheet [9]

Name of Company		Contact Person		Telephone No.	
Project Site/Location		Project Type [] Construction [] Demolition		Project Size (in square feet)	
	Pre-Project	Project Updates For Period: _____ to _____			
Material	Estimated Generation	Recycled/Salvaged/Disposed	Facility		
Total					
Signature		Title		Date	

5.3 Recycle techniques

The recycle technique is defined as utilising wastes as raw materials in another applications. Recycle endeavours can be successfully utilised during the execution phase by the Contractor. The Contractor's team's responsibilities in this stage could be as follows:

- The Contractor should recycle wastes that can not be reduced nor reused as described in [2]. Metals such as steel, copper and aluminium can be sold to factories in order to be recycled in producing new metals.
- The Contractor's team should assure that the recycled materials, such as recycled concrete or asphalt materials, are uniform in quality, of adequate grading, free from any contamination and meet with the Egyptian Specification and Code of Practice.
- The Contractor's team should crush all materials on site such as bricks, concrete, stone and marble in order to maximum their reuse as recycled aggregates and fill materials.
- The Contractor's team should stockpile all crushed materials in separate and secured designated storage areas to avoid contamination or deterioration by weathering.

5.4 Recover techniques

The recover technique is a process of generating energy from waste materials that can not be reduced, reused or recycled. Recover techniques can be exhibited during the execution phase by the Contractor. The Contractor can apply various waste recovery techniques such as briquetting, incinerating, pyrolysis, gasification and biodigestion [2] and [10].

5.5 Disposal

The last category in the waste management hierarchy is disposal. Disposing of wastes should be carried out in controlled landfills to prevent any contamination to water and soil. Therefore, there is a practical need to select, design, construct and operate the landfill sites with a proper environmental management system in order to protect the environment during the whole lifespan of the landfill. The main responsible in this phase is the Contractor. The major roles of the Contractor are to avoid the disposal option by implementing 4Rs Golden Rule and to manage the disposal of the inevitable wastes.

6. CONCLUSIONS

Based on the data collected from the literature survey and the questionnaires, it is revealed that the production of waste is escalating both on the international and national scales. The estimated rates of construction and demolition waste in Egypt have reached more than 33% of total municipal solid wastes which is approximately equivalent to 10,000 ton/day. Furthermore, environmental, safety, visual and technical related problems generated from demolition waste has severely added to the long-term negative impacts of these wastes on the surrounding environment.

The essence of the recommended guidelines in this paper is to offer systematic procedures that could help in minimising the magnitude of the demolition waste problem in Egypt. Therefore the disposal option can be avoided by the implementation of the 4Rs Golden Rule of reduce, reuse, recycle and recover to the demolition activities.

7. RECOMMENDATIONS

A continuous development process is recommended for the guidelines by monitoring the performance of the guidelines on ongoing projects. Thus, if any discrepancy or faults in the guidelines are detected, subsequent corrective actions would be taken to rectify, improve and upgrade the guidelines as shown Figure 2. Moreover, further developments are recommended to develop a scientific methodology to quantify demolition waste.

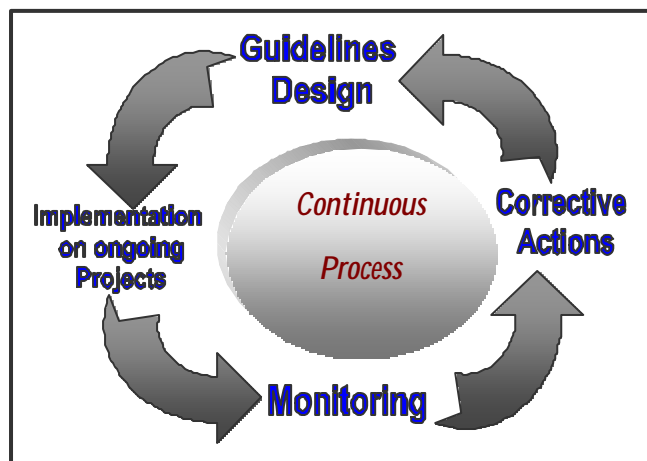


Figure 2: Continuous development of guidelines [2]

Furthermore, more political support is required to enforce the implementation of waste management scheme in the construction/building field. This could be attained, by firstly, adding some articles to the executive regulations 338/1995 of the Egyptian environmental law or issuing new decrees by the ministry(s) concerned to handle and manage demolition wastes. Secondly, diligent monitoring and follow up by municipalities and localities for illegal waste

disposal should be performed. This could be attained by creating special bodies for monitoring and following up. In addition, recruitment of licensed specialists is recommended to collect demolition waste under the direct supervision of authorities. Finally, incentives to abide by environmental legislation should be developed such as imposing a special tax levied on wastes when exceeding a certain level determined by the government.

It is also recommended to extend research on the area of recycling techniques of building materials to induct feasibility studies, including cost/benefit and payback period analysis for each technique. The research should survey the Egyptian market and seek the potential possibility of using waste as raw materials in factories. This research should integrate both the construction industry and the manufacturing industry to bridge the gap between the two disciplines.

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