EMERGENCY PLANNING FOR DISASTER WASTE: A PROPOSAL BASED ON THE EXPERIENCE OF THE MARMARA EARTHQUAKE IN TURKEY

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Abstract

Significant quantities of disaster waste were produced as a result of the Marmara Earthquake in Turkey in 1999. Following rescuing of people, there has been considerable problems in the handling of the demolition waste: there was no landfill site for demolition waste, the management of this waste type was uncoordinated, and separation of the demolition waste at source for recycling was not performed. If an emergency plan for such disasters has existed, it would have been easier to manage this waste type.

This paper aims to provide lessons from waste management experience of the Marmara Earthquake in Turkey and propose an emergency plan for such cases. Information will be provided about collection, separation, recycling activities and disposal of disaster demolition waste following the Marmara Earthquake. After determining the gaps and weaknesses in this experience, a proposal that would solve these problems will be presented. This emergency plan proposal includes criteria of site selection, handling, separation, recycling and disposal of disaster waste.

Keywords: Construction & demolition waste, rubble, disaster, earthquake, recycling, waste.

INTRODUCTION

On 17th of August 1999, an earthquake hit the Marmara Region in the north-western part of Turkey. The consequences of this earthquake were devastating as more than 15.000 people died and nearly 44.000 people were injured. The total length of the fault, was more than 500 km and caused damage to buildings to such an extent that more than 120.000 people were left homeless. Arising from the clearance of these damaged buildings, huge quantities of waste arose, especially in the provinces of Kocaeli, Sakarya, Bolu, and Yalova. The earthquake affected an area up to 500 km from the fault which included industrial zones.

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Handling of demolition wastes commenced after the search and rescue phase was completed. The demolition wastes were disposed of at 17 dumpsites throughout the region, as well as a number of illegal dumps.

For the possible recycling of the demolition wastes, two crushing plants were granted by the Swedish Company Svedala and located at the Kocaeli and Sakarya Provinces. Problems with these crushers arose, mainly due to the feed material into the crushers, which was mixed with contaminants (organic material) and thus not recyclable. Furthermore, the demolition waste contained excessive lengths of reinforcement bars, which got trapped within the equipment causing blockages.

The basic principle of assessing the amount of rubble generated in the region due to the earthquake was based on a damage assessment, carried out by a Damage Assessment Committee.

The damage assessment was divided into three categories:

- Destroyed/Heavily damaged buildings (demolished and removed to the disposal sites)
- Medium damaged buildings (estimated to amount to 20% of the total rubble generation from buildings to be completely demolished and removed to disposal sites)
- Lightly damaged buildings

The total amount of rubble generated in the Marmara region has been estimated as follows:

Province	**Rubble (tonnes)**
Kocaeli	6,020,000
Sakarya	5,000,000
Yalova	1,700,000
Bolu	460,000
Total	**13,180,000**

Table 1: Summary of the Rubble Assessment (UNDP Regional Management Plan for the Rubble in the Marmara Earthquake Region, Turkey)

One building contains an average of 4.2 house units, each of 100 m2. The amount of rubble generated per m^2 house unit is estimated at 1.3 tonnes.

It has been estimated that around 45 percent of Turkey's population lives in high-risk areas prone to earthquakes; mostly in or near urban areas. Thus, the extent of damage caused by the Marmara Earthquake is unfortunately not a sole occurrence.

Waste Composition

In the UNDP Project (UNDP, 1999) the composition of demolition waste has been classified into the following three fractions:

- Recyclable materials
  - Concrete (plain, reinforced, blocks, foundations and coverings)
  - Masonry (bricks, blocks and roofing tiles)
  - Wood (roof rafters, flooring, beams and internal materials)
  - Metal (reinforcement bars, internal installations, (heating systems) and bearing structures)
  - Soil and excavation material

- Non recyclable materials
  - Household inventory (all internal furniture and fittings)
  - Organic materials (household waste)
  - Other inert materials.

- Hazardous waste
  - Asbestos (from insulation, roofing sheets, etc.)
  - Chemicals (materials polluted with chemicals, paints, etc)

Typical composition of the rubble generated as a consequence of the Marmara Earthquake and disposed at dump sites is given at the Table 2.

Category (description)		**Percentage of total %**
Recyclable	Concrete	60
	Masonry	25
	Soil and excavation mat.	5
	Metals (inc. iron bars)	5
Non-recyclable (Wood, plastics, papers, organic material)		4
Hazardous		Less than 1

Table 2: Typical composition of the rubble

Based on the above mentioned assessments and evaluation of building waste composition, the following amounts of the different fractions can be identified, assuming a complete sorting of the waste at the table 3:

Province	Kocaeli	Sakarya	Yalova	Bolu	Total
Concrete (tonnes)	3,612,000	3,000,000	1,020,000	276,000	7,908,000
Masonry, plaster (tonnes)	1,505,000	1,250,000	425,000	115,000	3,295,000
Iron (tonnes)	301,000	250,000	85,000	23,000	659,000
Soil and excavation mat.	301,000	250,000	85,000	23,000	659,000
Wood, plastics (tonnes)	241,000	200,000	68,000	18,400	527,000
Hazardous waste	60,200	50,000	17,000	4,600	131,800
Total (tonnes)	**6,020,000**	**5,000,000**	**1,700,000**	**460,000**	**13,180,000**

Table 3: Amounts of recycling materials.

Assessment of Removing of Rubble

A Crisis Center (CC) was established within the Ministry of Environment after the 17th August earthquake. Technical specialists were sent by the CC in order to help local staff to determine sites for the disposal of demolition waste and other environmental issues.

During the first month after the earthquake, an emergency removal of the rubble was conducted and the search for people inside the damaged buildings continued. Furthermore, the waste was removed from roads and large areas to give access to vehicles. In this process no sorting of the demolition wastes was performed and it was disposed of at dumps appointed by the Ministry of Environment (MoE), as well as areas appointed by the municipalities or at illegal dumps.

The 17 dumpsites were utilized to capacity. These sites were selected in compliance with Regulation of Solid Waste Management, which excluded the disposal of demolition waste to sea, river, river bad, lake and agricultural areas. Experts of the MoE selected appropriate sites for demolition waste in the Sakarya, Kocaeli and Yalova.

Transportation

The transportation of rubble from the demolition sites to the disposal sites was undertaken by a combination of public and private sector vehicles. Especially, the public department of waterworks was very active in the province of Kocaeli. The private contractors operated in accordance with contracts with the relevant municipalities.

The typical vehicles used were 3-axle trucks with a capacity of 10 tonnes. It should be noted, however, that due to the large quantity of reinforcement iron bars in the concrete rubble, the trucks were not hauling rubble at optimal capacity with the reinforcement bars creating large void spaces.

DISPOSAL

Municipalities are responsible for the management (handling, recycling and disposal) of the rubble. Within the Marmara earthquake region, there were considerable differences in the management of the generated rubble. In some cases management of demolition waste was carried out by local governments and not the respective municipalities.

For some provinces the management of the large quantities of rubble proved a difficult task, normally due to urban, geographical and financial constraints. Due to the emergency response, small quantities of rubble were illegally dumped along the coastline. Collection of scrap iron in the rubble was often undertaken by individuals at the various disposal sites and only represented ad hoc and uncoordinated recycling.

17 dump sites were identified and approved for use by the MoE, these being selected in compliance with the Regulation of Solid Waste Management. The below map illustrates the 17 dump sites located in the Marmara Region.

1. Körfez Old Dump Site
2. Izmit Fair Site Across
3. Köseköy Industrial Zone Behind
4. Gölcük-Sarayli
5. Gölcük-Ford-Otosan Land
6. Karamürsel Exit
7. Old Gölcük Road
8. Ciftlikkoy
9. Cinarcik
10. Handere
11. Coastal Landfilling Area
12. Takisigi Stone Quarry
13. Gazeller Locality Svedala Jaw Crusher
14. Arifiye
15. Fevzicakmak Quarter
16. Doganli Koyu Quarry
17. Han Binasi Near

UNDP (2000), Regional Management Plan for the Rubble in the Marmara Earthquake Region, Turkey – *Final Report*

The management of the disposal sites varied with some provinces using the waste as engineering fill for the construction of new villages consisting of prefabricated houses as well as for land protection against occasional flooding of the river. This, however, requires certain precautions since demolition wastes can include small proportions of hazardous wastes, for example heavy metals, PCBs and asbestos, which requires that the waste must be controlled.

At other dump sites, the waste was disposed of in an uncontrolled manner, being spread all over a very large area, constituting a detriment to the surroundings and therefore hindering the subsequent collection/recycling of the rubbles.

Certain dump sites lay in valleys, which also created difficulties for the future collection/recycling of the waste, as well as destroying the landscape.

At two of the larger dumpsites, crushers were located as donated by the Swedish company Svedala. These were however delivered with limited training, supervision and assistance regarding their operations. Coupled with problems concerning the mixed nature of the demolition wastes (i.e. a high degree of organic content such as wood and paper making the rubble non-recyclable as gravel) as well as operations, these crushers were not fully utilised.

KEY FINDINGS

The demolition waste disposed of at the dumpsites is in principle recyclable (90%), if it was sorted and contaminants removed. However, the wastes disposed of following the earthquake were mixed with soil, carpets, clothes, wood and other materials, making it non-recyclable without lengthy and expensive pre-sorting. At the same time, the waste was normally disposed of at a location where it was almost impossible to collect the waste or it had been used as engineering fill.

The gaps in the management of potentially recyclable rubble from the earthquake may be classified as follows:

- The removal of rubble and other wastes had accumulated along roads, with subsequent removal to the dumpsites to give access to vehicles. *Finding*: uncontrolled tipping led to double handling of the wastes (increased costs and resources) as well as minimising recycling potential.

- There was an authorization gap where no department was accountable for the wastes, thus making control difficult. This lead disposal at dumps appointed urgently by the Ministry of Environment as well as by the municipalities. This led to confusion as well as high use of illegal dumps. *Finding*: Haphazard~~ly~~ spread of rubble making subsequent control and collection difficult.

- The transportation of rubble from the demolition sites to the disposal sites was undertaken by a combination of public and private sector vehicles. There

was no dedicated vehicle resource for removal of rubble. *Finding*: High number of contracts can lead to duplication, inefficient use of resources and lack of co-ordination in finance and resource allocation.

- For some provinces, the management of the large quantities of rubble proved a difficult task, often due to urban, geographical and financial constraints. *Finding*: The Municipalities were often overcome by scale of rubble generated, requiring resource assistance in order to cope. This may have been exacerbated by the lack of coordination in truck resources.

- During the emergency response period, small quantities of rubble were illegally dumped on the coastline. *Finding*: Hazardous materials in the demolition wastes can be potentially detrimental to the environment, as well as creating negative visual impacts.

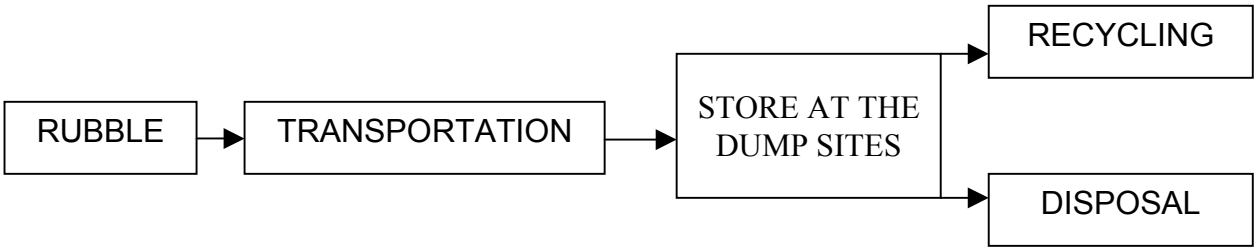
- At numerous of the dump sites, the waste was disposed of in an uncontrolled manner as the waste had been spread over a very large area, constituting a detriment to the surroundings and therefore hindering the collection/recycling of the rubbles. *Finding*: Critical impact on logistics and transport of materials if left uncontrolled. By doubling handling the wastes, critical resources were used in moving wastes twice, which have cost and resource implications.

- At some of dumpsites, the rubble was disposed in a valley. *Finding*: Dumping in valleys makes handling of the wastes difficult due to clopping banks minimising use of heavy machinery.

- Collection of scrap iron in the rubble was often undertaken by individuals at the various disposal sites and only represented ad hoc and uncoordinated recycling. Most of these wastes were mixed. *Finding*: Recycling activities should be promoted at the source in order to prevent mixing with other waste streams.

- Local disposal site capacities were not sufficient for the significant amounts of rubble generated. *Finding*: There is a need to select alternative sites in case of post-disaster planning.

Table 4. A summary of the management of demolition wastes.



General Principles and Strategies of a Disaster Demolition Waste Management Plan

As can be appreciated from the key issues identified from the Marmara Earthquake, there is a clear requirement for an Emergency Plan for demolition wastes arising from earthquakes in Turkey.

The key principles of such a plan are:

1. The conservation of natural resources.
2. Reduction of quantities of wastes for final disposal.
3. Minimisation of the negative environmental impacts caused by waste.

MEASURES FOR EMERGENCY PLANNING

The following components are recommended included in an emergency plan for demolition wastes.

Organisation and authorisation

- To determine roles and persons
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    - To determine contact person who will manage demolition works, (name, phone, address etc)
    - To establish Disaster Emergency Authorisation (from the public agencies and municipalities by the head of governor)
    - To determine quantity of rubble,
    - To determine number of trucks and demolition contractors for transportation of rubble
    - To determine Disaster-Debris Service Providers. Following a disaster, there may be a need to contract with demolition/excavation contractors, debris box haulers, or others to assist in the recovery process.

Resource requirements

- To determine facilities
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    - To select potential provisional storage areas for recycling of rubble.
    - Landfills. After a disaster, existing landfills may be used as storage, transfer or processing sites for resulting debris. Landfills can also be utilised for some recovered material in their operations.
    - Transfer Stations

Criteria for Waste Recycling / Disposal sites

- Location sites should be identified that are accessible to areas particularly susceptible to disasters (e.g. near urban centres, freeway interchanges)
- Make a list of possible sites: public and private.
- Develop Site Operation Plan
- Develop Site Restoration Plan.

- Sites should be of sufficient size to allow for the storage of disaster debris material and the safe movement of vehicles.
- Compatible land uses; sites should be identified in areas with land uses that are compatible with heavy truck traffic, dust, and noise.
- Protection from additional disaster events; sites should be situated away from known active earthquake faults.
- Avoidance of environmentally sensitive areas; sites should avoid environmentally sensitive areas such as wetlands and endangered species habitats.

The cities and the municipalities are encouraged to identify potential sites before a disaster strikes, and to consider permitting and pre-approving the use of identified sites for disaster debris. Negotiating the lease or use of privately or publicly owned land before a disaster can also save valuable time.

Technical requirements for recycling operations

For the recycling of the rubble, the following decisions can be made in the pre-disaster mitigation planning:

- Selection of crusher and screening types with address/contacts to supplier and average cost basis.
- Trained personnel at hand to operate the machinery
- Quality control plan for use during the recycling process to ensure recycled material of satisfactory quality.
- Spare parts and service agreements required for the equipment
- Diesel and other supplies to be planned for.

CONCLUSION

This paper has presented the key issues relating to the management of demolition wastes following natural disasters, with a special focus on earthquakes.

Lessons learnt from the 1999 Marmara Earthquake in Turkey provides the basis upon which a proposed emergency preparedness plan for managing demolition wastes is proposed.

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