Construction Waste – Potentials and Constraints

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Abstract

The construction industry is a major generator of wastes and other seemingly unusable materials that can easily be discarded as solid waste. Basically, contractors are responsible for maintaining a sanitary work environment and to dispose of their waste from their working area. Since the presence of the contractors is contingent to the construction period, the primary method of getting rid of the construction waste is to haul them away from the work sites, without much regard to the long term repercussion of their actions. As the focus of compliance in most construction sites is on the maintenance of sanitary surroundings, the management methods for waste which considers reuse, recycling and resource recovery are not clearly followed through. With this prevailing conduct of business, the construction industry misses its mark in contributing to correct waste management. Materials, be it excess from construction process, or residual from demolition, can still be usable should the contractor exert efforts in finding ways to use them rather than dispose them. At worst, when not fully checked by the supervising engineer, these materials end up dumped in the surroundings, which can potentially cause contamination to the environment. This paper presents the issues of construction wastes encountered by the author in projects that he worked on, with some suggestions on how these materials easily regarded as waste can be reused. In addition, the author also presents some issues that lead to lax implementation and enforcement of proper waste management in the work sites. Finally, recommendations are presented that the construction industry can espouse in order to improve the compliance of the construction industry to an ecological solid waste management.

1. Introduction

The construction industry is considered one of the drivers of economy and nation building. Its contribution to
the gross national product is considerable and its positive ramifications on the local and regional economy can be
tremendous as it opens up employment and business opportunities. Infrastructure projects such as road, major
bridges, railways, ports/airports and other major civil works are avenues for major capital influx into the areas where
work will be undertaken. The impact to downstream economy can be immediate at the start of the construction and
can continue during the operations itself. It is for this reason that local residents get excited when new major
infrastructures are established in their locality. Coupled with the promised economic and financial benefits of the
construction industry, the activities themselves generate considerable waste materials at the worksites, workers’
campsites, and ancillary facilities. These waste materials, generally termed as construction waste, are part of
construction materials’ packaging, containers, and spent machinery and equipment parts that are no longer usable.
Hence, with no practical usage of these materials in the construction, there is no reason to keep them and are,
therefore, subsequently disposed.

If these materials are improperly managed and disposed, they can cause some irreparable and irreversible adverse impact to the environment. Consequently, people’s health and welfare can be compromised; foremost of all will be the workers and subsequently, the residents themselves in the vicinity of the project sites. It can end up in a scenario wherein the promised development is overshadowed by an environmental catastrophe.

Construction wastes are generally bulkier, heavier and at times more toxic than domestic waste. Their disposal to a local sanitary landfill or dumpsite can prove to be less of a solution but more of an aggravation of the issue in the long run. In some instances, the contractor resorts to inappropriate or even illegal practice such as: (i) illegal dumping in deserted areas; (ii) concealing garbage in wooded or forested areas; (iii) mixing with domestic waste; (iv) burying in abandoned sites; (v) dumping in waterways; and (vi) burning.

On the other hand, a good portion of these construction wastes can still be usable with proper planning and their usage can be a solution itself to the burgeoning waste issues that the communities and the construction industry face. One would just have to be creative and resourceful in finding solutions to these issues.

In the environmental monitoring work of the author for the construction of major infrastructures funded by international funding institutions (IFI’s), solid waste management at the worksites is always a recurring issue. In the urban setting, the construction industry figures in the real estate sector where issues on waste generated follow the localities regulations. Quite considerable attention is accorded on this sector as they had been more visible and exposed to public opinions in their surrounding localities.

A new perspective should set in. Materials accumulated at the worksites are not problems to be removed, but rather as opportunities to be utilized, which can be of some financial benefits as well as means to conserve the resources from the environment. Subsequently such viewpoint can contribute to sustainable construction activities that the industry should rightly aspire for, as their share in the overall efforts at protecting the environment.
This paper deals with construction waste issues for major infrastructures (particularly transport infrastructure, which the author has experienced), which straddle a number of communities and localities with their respective levels of solid waste management implementation.

2.0 Review of Literature

This paper is mainly derived from direct experience of the author on the encountered issues of construction waste in the transport infrastructure that he worked on. Much of the literature and printed documents used as reference were project reports (progress reports, EIAs/EMPs), technical specifications, contract documents and correspondences. In addition, desktop review of electronic reference sources was also conducted to gain a wider perspective. There is a considerable volume of literature pertaining to construction and demolition wastes. However, most of them refer to erected buildings rather than on civil works infrastructure.

A lot of literature on construction waste available over the internet as well as on printed articles deal with the real estate sector such as that of presented in an article by V. Nitivattananon & G.Borongan (2007). In some instances, some waste management aspects of civil works involve recycling asphalt, concrete, steel and other metals.
Conversion of old concrete into aggregates to be mixed with new concrete mix was discussed in a technical paper by C. M. Vyas & D. R. Bhatt (2013). What is missing is a more comprehensive deliberation of waste in civil works construction and implementation.

3.0 Approach and Methodology

Primary data were gathered and compiled during the construction supervision of projects in actual inspections of a number of sites and facilities. Discussions with the contractor’s environmental staff as well as with construction supervision engineers were held to determine some root causes of the issues. The projects covered by this study were roads being constructed in Azerbaijan, Georgia, Kazakhstan and Tajikistan; and one railway in Turkey as shown in the table below:

| Location                        | Project Description                                      |
|---------------------------------|---------------------------------------------------------|
| Salyan, Azerbaijan              | 50km Four-lane highway with 1.2km bridge                |
| Kuboleti-Batumi, Georgia        | 48km Four-lane highway with bridges and interchanges    |
| Ayni-Panjekent, Tajikistan      | Two-lane highway with 31 bridges                        |
| Ankar-Istanbul, Turkey          | 400km of railways with tunnels and viaducts             |

Periodic visits were done by the author on these project sites as part of the continuing environmental audit of the job-performance of the contractor. In these instances, issues on solid waste management in these inspected areas were discussed with the contractor along with strict instructions to remedy the situation.

4.0 Management Provisions of Construction Waste in Project Documents

Solid wastes in general and construction wastes in particular, are among the environmental issues that need to be covered in the environmental protection aspects of the project. The EIA system required in most internationally funded projects focus on protecting both the physical and social environment. Along with other issues, the generation of domestic waste by people working and staying at the project sites is included. Accumulation of construction waste becomes unavoidable due to the quick pace with which materials are being utilized for the construction.

Although the subject of solid waste and construction waste are recognized during the preparation of the contract documents, they fall short on being effective in realizing the objectives of ecological solid waste management. The table below shows some of the provisions encountered that dealt directly with solid waste and construction waste at the work sites.

| Location                        | Project/Document | Specific Provisions                                                                 | Remarks                                      |
|---------------------------------|------------------|-------------------------------------------------------------------------------------|----------------------------------------------|
| Salyan, Azerbaijan              | Contractor’s EMP | Waste Management Plan as annex the EMP discusses responsibilities of personnel     | No mention on management of construction waste |
|                                 | Technical        | Contractor’s responsibility on disposing waste from the site                        | Generally means removal; no compulsion for   |
|                                 | Specifications   | Management of Solid Waste From Construction and Construction Camps:                 | undertaking 3Rs                              |
|                                 | Technical        | i) Wherever possible recycling / re-use of materials shall be considered.             | Compliance of Contractor is weak;            |
|                                 | Specifications   | ii) As a rule, solid wastes generated during the construction phase shall be        | Lacking in enforcement mechanisms            |
|                                 |                  | systematically collected, stored and disposed of in suitable locations.              |                                              |
### Location | Project/Document | Specific Provisions | Remarks |
--- | --- | --- | --- |
Kuboleti-Batumi, Georgia | EMP | - Construction debris (waste from bridge demolition, the replacement of culverts, crash barriers or handrails from bridge etc.) shall generally be removed from the site and disposed of in accordance with the existing regulation.  
- Domestic waste from temporary construction camps shall be systematically collected and hauled to the designated areas.  
The Contractor shall  
- Develop waste management plan for various specific waste streams (e.g., reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to RD for approval.  
- Prohibit burning of solid waste  
- Collect and transport non-hazardous wastes to all the approved disposal sites. The sites for waste disposal shall be agreed with the local municipal authorities. The specialized company will be contracted to ensure collection of domestic and general waste from camps and temporary storage areas and transportation to the landfills.  
- Vehicles transporting solid waste shall be covered with tarps or nets to prevent spilling waste along the route  
- Provide refuse containers at each worksite. | Compliance of Contractor is weak; Lacking in enforcement mechanisms |

Ayni-Panjekent, Tajikistan | EMP | The contractor shall be responsible for the following:  
- Provide refuse containers at each worksite;  
- Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal;  
- Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process, and  
- Collect and transport non-hazardous wastes to all approved disposal sites. The sites for waste disposal shall be agreed with the local municipal authorities and the Department of Environmental Protection (DEP). A specialized company may be contracted, if available, to ensure collection of domestic and general waste from camps and temporary storage areas and transportation to landfills approved and licensed by the DEP. |

Ankara-Istanbul, Turkey | EIA | A Waste Management Plan (WMP) must be developed by the Construction Contractor. In the first instance the WMP is based on a management hierarchy whereby the priority will be to:  
- Avoid generating the waste in the first place;  
- Minimize the amount that is produced;  
- Recover wastes through recycling and reuse;  
- Treat and process the waste, without causing secondary impacts to soils, water resources and air quality;  
- Dispose of the waste in a controlled way (i.e., to a licensed facility), without compromising existing waste management capacity. | Compliance of Contractor is weak; Lacking in enforcement mechanisms |

### 5.0 Major Issues in Construction Waste Management in Transport Projects

In the transport projects being considered in this study, the main sources of solid wastes and construction wastes are as follows:

1) **Contractor’s work Camp** – mainly domestic waste, packaging, containers, and domestic waste/rubbish.  
2) **Fabrication yard** – scrap metals, machinery parts, used tires, containers, and packaging.  
3) **Equipment yard** – machinery parts, used tires, containers, and packaging.
4) **Ancillary facilities (concrete batching plant, asphalt plant, satellite offices)** – excess bitumen, cement mix, and containers.
5) **Work site** – wood, wires, steel, concrete, old asphalt, excess soil, sand, and domestic waste/rubbish
6) **Subcontractor’s facilities** - mainly domestic waste, packaging, and containers

In the construction supervision of the aforementioned transport projects, some notable cases encountered by the author were as follows:

1. **Excess cement mix discarded on the ground** –

   *(Salyan Road Project, Azerbaijan)* During concreting activities, transit mixers bring cement mix to structural components being casted. In some occasions, especially at the final stages of concreting, excess cement mixes are still left inside the concrete mix. To avoid hardening and causing mechanical difficulty, it would be advisable to remove the cement mix from the chamber. Hence, as the usual practice, the transit mix operators would decide to just dump the excess cement in the surroundings (see Figure 1). This results in having lumps of cement, which later hardens and becomes eyesore to the surroundings, consequently affecting plants and some animals that thrive in the area or at time these dumped cement mix get into bodies of water and become source of contamination. With proper management and planning, this excess cement mix can be used as lean concrete paving in some areas. The site engineers can find creative ways to find use for such materials rather than be a source of contamination at the site.

![Fig. 1. Excess cement mix dumped onto the ground](image)

2. **Used tires should be recycled** –

   *(Salyan Road Project, Azerbaijan)* Used tires no longer needed should be sold back to manufacturer or to recycling company. One bad practice encountered is the burning of tires to heat up and liquefy sealant for drainage structures. Burning of tires generate noxious fumes, which can be hazardous to workers, fouls the surrounding air and release toxic chemicals and particulates into the air. The resulting ash residues (see figure 2) are toxic and contaminates the surroundings. Recycling of used tires can be a good source of revenue which, when properly organized, can be attractive to the contractor. Temporary stockpile of used tires can be designated near the equipment yard for some recycling businesses to regularly collect.

3. **Reinstatement of Borrow Pit** –

   *(Kuboleti Road Project, Georgia)* Some machinery parts or used items can still be recycled, or can still be used for other purposes. Any material can be welded, joined, or fabricated into other items. The challenge though is to find uses of these items at the jobsite. Oftentimes since these materials were already paid for, incentives to find uses
in the construction becomes secondary. However, the potential exists, since the materials are available for other uses. Either the contractors reuse them sell them to private individuals who can find certain uses for them or resell them to recyclers (Figure 4).

4. Old asphalt materials can be mixed into new bituminous mix -  
(Ayni-Panjekent Road Project, Tajikistan) With the construction of new pavement, old asphalt materials are to be removed and replaced by new bituminous layers. Old asphalt can be milled into proper sizes and could be mixed into new bituminous asphalt mixtures. Doing this will minimize stones to be quarried; thus resulting into conservation of materials and minimization of quarrying activities. In some instances, old asphalt can be used as paving in some minor rural roads as surface paving on earth roads. Also rural folks can use them in their driveways as pavers. Not using them can be just an eyesore to the surroundings or some constituents may leach into the ground and become a source of contamination in the stocking area. Hence, it is more practical to find use for these items rather than just let them to sit in the worksite.

5. Empty barrels River -  
(Ayni-Panjekent Road Project, Tajikistan) Bitumen barrels when stocked in huge numbers can be a source of contamination. Such containers can still be usable for a number of purposes. As with other materials, the challenge is to find good use for them. In instance when hauling cost is expensive, donating them to the public for other
domestic use (e.g., as containers for farm supply or implements) may be a better option in order to get rid of a potential contamination issue. This can be viewed as an act social service to reach out to the community and improve relations—can rightly be viewed as opportunity.

6. Piles of assorted materials-

(Ankara-Istanbul High Speed Train Railway Project, Turkey) In the construction of high-speed railway from Eskisehir to Gebze (near Istanbul), there are around thirty-four (34) tunnels and twenty-two (22) viaducts. Such undertaking generated considerable amount of construction waste in a number of locations. In fact, with the usage of huge tonnages of steel and cement, a lot of these materials were accumulated at the material and equipment zone of the campsites. One major challenge is that, materials brought from works sites to the collection site were rarely sorted. Hence, they ended up piled one atop another in a topsy-turvy manner. Such piling is a major eye-sore, a source of contamination and can be safety concerns to the people at the campsite. Proper planning should be established to minimize such site accumulation. Material segregation is necessary in order to hasten the selling or removal of such materials from the site and eliminate potential sources of contamination.

![Fig. 6. Piles of assorted materials need to be re-sorted and sold to recyclers.](image)

5.1 Project Stages Where Construction Waste can be Dealt with

In general, IFIs do realize the importance of incorporating environmental safeguards within the project cycle by establishing the EIA systems as guidelines for the project from its inception up to completion and handing-over of the project to the Client. The project stages are presented in the table below along with relevant interventions for construction waste issues.

6.0 Conclusions and Recommendations

In principle, the environmental and social safeguards fostered by IFIs and local regulations in host countries work coordinately to ensure optimal protection of the environment balanced with economic development. Although much of the attention is focused on protecting the ecological resources, pristine physical features and social fabric, the impacts that are caused directly and indirectly by construction waste and solid waste are at times marginally considered. When left unheeded, such neglect can even lead to adverse impacts affecting the ecology, as well as the physical and social environment.

Two opposing forces seemingly act against each other—(i) expediency in completing the project on time and within the budget; and (ii) the desire to preserve and conserve the environment. These two forces can be complementary to each other. Both have the same aim of improving the lives of the people where these
infrastructures are being built.

Side by side the perceived impacts of the generation of construction waste, potential benefits can be derived by the contractors and the communities. Used manufactured materials can be available to anyone, either by way of recycling or reuse. The following are among the recommendations that can be applied throughout the entire project implementation and coordination:

1) **Proper management of construction waste should be part of the Employer’s Requirements** – The Employer (Client/Owner) should clearly and specifically mention that construction wastes should be minimized at the worksite through the 3R’s – reduce, reuse, recycle. If the owner shows interest and sufficient emphasis on establishing this in the project, the contractors will be compelled to follow that lead.

2) **Penalty Clause for improper construction wastes management should be included in the contractual provisions** – Financial instrument such as penalty for non-compliance prove to be effective in realizing results. Penalty clause should be part of the specifications and should be employed upon whenever necessary. Other sanctions can also be imposed such as delay or reduction of payment whenever lapses occur in the implementation of the construction waste management.

| Stage                  | Responsibility                  | Activities                                                                 | Interventions for Construction Waste Issues                                                                 |
|------------------------|---------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Project preparation    | Proponent (who later becomes the Employer or Client) | “Screening and Scoping Process” - determines the level of detail that the environmental assessment and the important environmental issues to be tackled Assignment of Categorization based on project expected environmental impact as follows: (i) **Category A** - Projects could have significant adverse environmental impacts and EIA is required. (ii) **Category B** - Projects could have some adverse environmental impacts, but of lesser degree or significance than those in **Category A**; and an IEE is required. (iii) **Category C** - Projects are unlikely to have adverse environmental impacts. No EIA or IEE is required. | The screening and scoping process can start considering the magnitude and impact of construction waste. Categorization can be adjusted to consider the relevance of the construction waste. EMP should provide more comprehensive means and measures to manage construction waste and solid waste. Clear guidelines should be provided. Reference to local laws covering construction waste should be referred to. More thorough and detailed requirements for management measures for construction waste and solid waste to be reflected in the Technical Specifications and EMP. Innovations using recycled materials should be included in the designs. |
| Design stage           | Design Consultant               | Instrumental parametric measurements of air, water, and noise are normally required of the Contractor and to be monitored by the CSC. | Compliance with 3Rs for construction waste should be included as among the regular parameters to be monitored. Auditors should inspect the status of management of construction waste and solid waste. Sound construction waste management as part of the contractor’s EMP should be clearly drafted. |
| Construction           | Construction Supervision Consultant (CSC) or the Engineer | The Terms of Reference (ToR) of the Construction Supervision Consultant (CSC) or the Engineer contains specific tasks and scopes relevant to the environment. | |
3) **EMPs should specify mitigation measures for construction waste** – EMP’s in the EIA are quite comprehensive in the aspects of contamination to air, water and soil. Bad practices in handling construction and solid wastes eventually lead to contamination of these basic environmental attributes. Prevention of wrongful act is a lot better than the mitigation itself. The EMP’s should be more detailed and thorough in presenting the required mitigation measures.

4) **Contractors should produce Waste Management Plan that includes construction waste** – Part of the contractual and documentary requirements in some projects is the submission of the Contractor’s EMP, in which Waste Management (WMP) Plan is a component. The proper construction waste management show distinction between construction waste and normal solid waste and should present strategies for the 3Rs.

5) **Contractors organize their purchasing so as to avoid accumulation of waste materials** – Planning takes also a central role in minimizing construction waste and this can be easily done at the purchasing stage. The contractor should balance his needs and requirements for materials against accumulation of waste materials it can generate; such as in purchasing tires..

6) **Contractors should require suppliers to haul away also used items** – One scheme of minimizing the accumulation of materials on site is to require suppliers to haul away any remaining parts of the used materials away from the site. This can be used as the back-load of delivery trucks bringing materials to the site..

7) **Design engineers should incorporate opportunities to use recycled materials but without compromising quality** – The design of the projects play an important role in the overall directions of the construction. One aspect that needs to be looked into is the usage of recycled materials from demolition. Materials such as steel, wood, gravel, sand, asphalt and concrete can be recycled and put back into the construction. Old asphalt pavement can be milled and mixed with bitumen and can form part of the asphalt mix to be applied as new pavement.

8) **Contractors should have segregation/sorting activity on site** – Distinctly sorted materials at the site becomes more attractive for recyclers to buy. In addition, well-sorted and segregated materials can facilitate their creative usage in the project since site and personnel can clearly see the available materials for their needs.

9) **Contractor should popularize recycling and SWM in his project** - The contractor should have an active policy at the construction site or throughout the entire organization to recycle whatever is possible. If the contractor emphasizes on this policy and adopts it as a norm throughout the entire organization, the employees will be willing to absorb and implement it.

The above-mentioned approaches can create a significant increase in the degree with which construction waste can be utilized in the project site. It should be emphasized that the success of managing construction waste lies not only on the technical aspects but also on sound management practices and the resolve of the other major players (Employer and Funder) to attain clear objectives. Furthermore, the success of the project in providing the right infrastructure or civil works within specifications and budget is further enhanced and affirmed by the degree of protection and preservation of the environment and the people who will use it.

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