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A REVIEW ON CONSTRUCTION AND DEMOLITION WASTE QUANTIFICATION MODELS

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Abstract: ***Quantification is crucial for C&D waste management. Construction and Demolition waste is recognized as a dominant problem in the construction phase of pre building and post building. On one side, wastes impose a negative impact on the efficiency of the construction project and on other side it increases the overall cost of project without productivity. Construction and demolition (C&D) waste can be defined as ineffective utilizations of any construction products during the entire project phase. It mostly includes brick, concrete, timber, metal, etc. This review paper presents the qualification model for the assessment of waste that is generated from the construction industry.***

Keywords: **Construction and Demolition, Waste Estimating, Waste Quantification, Quantification Model.**

I. INTRODUCTION

In recent year due to speedy development of the construction industry, the huge amount of waste is generated from construction industry. Along with speed increases of GDP, in last decades. Most of the construction and demolition waste is delivered to local areas for simply disposal of landfilling. The issue of construction waste is important because it adds unproductive cost to the project and has a negative impact on environment. Construction means the process of erecting of building. Demolition means breaking down the buildings and other structures or dismantling of the components of buildings.

C&D wastes comprise of wood, concrete, metal, bricks and masonry. It also includes quantities of timber, metal, plastic, etc. C & D waste may also produce significantly from environmental disasters such as earthquakes, hurricanes and flood water. C & D waste can be divided into three categories: (1) Construction Waste (CW), (2) Renovation Waste (RW) and (3) Demolition Waste (DW). Components in C & D waste are inert materials like (concrete, bricks, etc). The most common problem that arises in construction waste management is the selection of the proper demolition practice and better planning practice. Demolition methods are mostly expressed in 3 groups: (1) Conventional demolition, (2) Complete selective demolition and (3) Partially selective demolition.

TABLE I: - Past work on C&D waste generation

Author name	Region	Year	Estimation level	Waste generation activity	Method
McBean and Fortin	Canada	1993	RL	CNB,DOB	GRC
Gavilan and Bernold	US	1994	PL	CNB	SV
Yost and Halstead	US	1996	RL	CNB	SV,GRC
Poon	Hong Kong	1997	RL	DOB	GRC,LA
McDonald and Smithers	Australia	1998	PL	CNB	SV
Formoso et al.	Brazil	2002	PL	CNB	SV
Fatta et al.	Greece	2003	RL	CNB,DOB	GRC
Poon et al.	Hong Kong	2004a	PL	DOB	SV
Poon et al.	Hong Kong	2004b	PL	CNB	SV
Begum et al.	Malaysia	2006	PL	CNB	SV
Cochran et al.	US	2007	RL	CNB,DOB	SV,GRC
Lau et al.	Malaysia	2008	PL	CNB	SV
Kofoworola and Gheewala	Thailand	2009	RL	CNB	GRC
Cochran and Townsend	US	2010	RL	CNB,DOB	LA,Other
Llatas	Spain	2011	PL	CNB	SV,GRC
Lu et al.	China	2010	PL	CNB	SV
Saez et al.	Spain	2012	PL	CNB	GRC
Li et al.	China	2013	PL	CNB	SV,GRC

CNB- Construction of new buildings; DOB- demolition of old buildings; PL- project level; RL- regional level; SV - site visit; GRC- generation rate calculation; LA – lifetime analysis.

II. CLASSIFICATION CRITERIA

The C&D waste is produced by the lifecycle of the project involving construction, renovation and demolition. Relevant to the waste generation amount, there are three preliminary waste generation activities can be classified: (1) constructing of projects, (2) demolition or rehabilitations of old buildings and (3) Civil and Infrastructural works.

1) **Constructing of projects:**The causes of waste production is include timber formwork, concrete work, masonry work and material handling, compatible for 30%, 13%, 13% and 10% respectively. The main factors was affecting the waste generation of newly Constructed buildings are construction method, project size, building type, material storage method, human error and technical problem**.**
2) **Demolition or rehabilitations of old buildings:** The demolition activities can produce a huge amount of the waste. Proper processing should be adopted to reduce the environmental impact because of the subsistence of hazardous substances. Proximately almost every products tending to more than 90% of the demolished structures were ended as waste except some materials that have longer life period of application like wood, steel, etc .
3) *Civil and Infrastructural work:* Civil and infrastructural works, such as roadways, highways, bridges, airports, dam, etc. This kind of Projects are usually with huge volume and long duration, Thus engender massive waste.

III. C&D WASTE QUANTIFICATION MODEL

Several waste Quantification models with different perspective, accuracy levels and end results have been presented by authors, namely, Yost and Halstead(1996), Franklin Associates(1998), Gheewala and Kofoworola (2009), Lu. (2013), Martinez-Lage (2010) and Llatas (2011).

TABLE II: - Different C&D waste models

Author	Year	Country	Model
Yost and Halstead	1996	United State	Waste generated during construction = The product of 'Level of activity of construction, rehabilitation or demolition' and 'waste produced per activity'
Fatta	2003	Greece	CW = [NC + EX] x VD x D where, CW = Waste from construction (tonne) NC = Construction of new structure (m^2) EX = Extent of infrastructure (m) VD = Volume of waste generated(m^3/m^2) D = Density of waste (kg/m^3) DW = ND× NF × SD×WD× D where, DW = Waste from demolition (tonne) ND = No. of Demolitions NF = Mean value of no. of floors of the building SD = Surface area of building that is demolished(m^2) WD = Rate of waste generation each demolition (m^3/m^2) D = Density of product of waste
Gheewala and Kofoworola	2009	Thailand	$Q_x = A \times G_{av} \times P_x$ where, Q_x = Quantity in tonne A = Area of activity(m^2) G_{av} =Rate of waste generation(kg/m^2) P_x = Waste material (%)
Weisheng Lu	2010	South China	$WGR = \sum m_i / A$ where, WGR = Rate of waste generated (kg/m^2) m = Quantity of one waste material for a single bucket A = Area for weighing and sorting
Martinez-Lage	2010	Galicia (Spain)	$R = \sum_{counties} (C_c . S_{Ci} + C_R . S_{Ri} + C_D . S_{Di})$ where, S_c = The surface area under new phase of construction S_R = The surface area under renovation S_D = The surface area under Demolition C_C=Quantity of waste per surface area of new construction C_R = Waste per area under renovation C_D = Waste per area under demolition.

C. Llatas	2011	Spain	$CW_B = \sum_{ji} CW_{pi} + \sum CW_{Ri} + \sum_{ji} CW_{Si}$ where, CW_B = Volume of waste expected CW_{Pi} = Expected volume of packaging waste element i $\sum CW_{Ri}$ = Expected volume of remains from building element i CW_{Si} = Expected volume of soils in building element i $CW_{Pi} = \sum_k (EWL)_{pk} Q_i F_P F_C F_I$ $CW_{Ri} = \sum_k (EWL)_{Rk} Q_i F_R F_C F_I$ $CW_{Si} = \sum_k (EWL)_{Sk} Q_i F_S F_C F_I$ Where, $(EWL)_{PK}$ = Packaging code $(EWL)_{RK}$ = Code specifying remains $(EWL)_{SK}$ = Code specifying soil Qi = Amount of building element 'i' FP = Factor of packaging waste FC = Factor of conversion FR = Factor of remains FS = Factor of soil FI = Factor of increased volume.

IV. CONCLUSION

- As we all know that C&D waste management becoming a crucial issue for most countries.
- To overcome that situation, this paper gives various quantification models developing the different countries for finding CDW quantity.
- It is concluded that the total amount of C & D waste generated is higher from demolition project than construction project.
- Effective management practice and proper planning can significantly improve the waste that is generated and enhance the reusability of waste from demolition in productive way.
- From above literature study I have find some research gap which described in below :

MODEL PAPER	**ESTIMATION LEVEL**	**LIMITATION**
Lau. (2008), Lu et al.(2011)	Project Level(PL)	For successfully implementation of model it requires support from contractor, consumption of time, money and labor.
Poon (2004b)	Project Level	This method can only approximately reflect the amount of waste generated from the site
McBean and Fortin(1993)	Regional Level (RL)	In this method C & D waste generation is more construction related and this method is not suggested if construction related statistics can be derived.
Yost and Halsted(1996)	Regional Level	This method is not suggested when the area of construction demolition activities can be directly derived.

Fatta (2003) and Lage (2010)	PL RL	In this method demolition area statistics may not available at regional level.
Poon (1997)	RL	In this method the detailed wasted amount at material level cannot be derived.
Cochran and Townsend (2010)	RL	This method similar to building lifetime analysis but appropriate assumption of material lifetime is required.
Wimalasena (2010)	PL RL	As the realistic data for C & D waste estimation is rare, this method has not get a wide application.

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