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Assessment of Construction Waste Generation at Building Sites: Site Survey, Categorization and Percentage Analysis

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Abstract: ***This paper presents a site-survey method for measuring construction waste at building sites and expressing it as category-wise percentages. Waste is sorted at source into ten categories (concrete and mortar, bricks and blocks, tiles, steel, timber, plastics and packaging, plaster and gypsum, glass and aluminium, paint and chemicals, soil and other), weighed on site across three construction stages, and analysed for percentage share, waste generation rate per m² of built-up area and material wastage percentage. Published studies show compositions ranging from masonry-dominated to timber-dominated depending on construction system, and Indian national estimates of C&D waste vary by more than an order of magnitude, which shows the need for site-level data. A worked example with placeholder figures illustrates the analysis, and the paper closes with minimization measures arranged by the waste hierarchy. Field data should replace the placeholder values in Section 4 before the findings are reported.***

Keywords: construction waste, C&D waste, building sites, waste categorization, waste percentage analysis, material wastage, site survey.

I. INTRODUCTION

Building sites generate a large and poorly measured waste stream, and knowing what the waste is made of is the first step to reducing it.

A. Background

Construction and demolition (C&D) waste is among the largest solid waste streams in fast-urbanizing countries. In India, national estimates are inconsistent: figures from the 2000s were around 12 to 15 million tonnes a year, while the Building Materials and Technology Promotion Council (BMTPC) later put the figure near 150 million tonnes a year, and the Centre for Science and Environment (CSE) argues the true figure is higher still (CSE, 2020; CPCB draft guidelines, 2017). CSE also reports that only about 1% of this waste is recovered and recycled.

Most of these estimates are top-down. Bottom-up, site-level measurements are scarce, which is why Ram and Kalidindi (2017) built waste generation rates from 45 case studies to estimate Chennai's C&D waste. A commonly quoted planning figure is 40 to 60 kg of waste per m² of new construction (Waste Management World), but site practice, building type and construction stage change this considerably.

B. Problem Statement

Without site-level data on how much waste is produced and in what proportions, contractors cannot target the largest losses, estimators cannot set realistic wastage allowances, and local bodies cannot plan segregation, reuse or recycling.

C. Aim and objectives

The aim is to assess construction waste generation at building sites through a field survey. The objectives are:

1) To identify and categorize the waste materials generated at building sites.
2) To quantify each category by weight and express it as a percentage of total waste.
3) To estimate the waste generation rate per m² of built-up area and the wastage percentage of key materials.
4) To identify the main causes of waste and recommend minimization measures.

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D. Scope and limitations

The study covers new building construction only: demolition and renovation waste are excluded. It reports on-site waste at the point of generation, not waste after transport or at disposal facilities. Results apply to the sites surveyed and are not a national estimate.

II. LITERATURE REVIEW

Published composition and wastage figures vary widely by country, building type and method, so they serve as benchmarks for the survey and not as targets.

A. Reported Waste Composition

Studies that sort and weigh waste report very different mixes because structural systems differ. Timber dominates wood-frame construction, while masonry and concrete dominate in block-and-RCC construction.

Table 2.1. Reported waste composition in published studies.

Study / setting	Main findings	Source
Malaysia, institutional / residential / commercial projects	Wood 48% to 69%, concrete 12% to 26%, bricks 7% to 14%, metals about 10%	Europe Proceedings table
Yazd, Iran (12-month disposal site sampling)	Cement and concrete about 38%, bricks about 20%, tiles and ceramics about 14%, ferrous metals about 11%	Core.ac.uk record
Commercial building, Iraq (excluding soil)	Bricks 47%, concrete 19%, mortar 11%, ceramics and marble 7%, gypsum 5%, steel 3%, wood 2%	Riarte record
Sri Lanka, demolition waste	Brick 25%, concrete 20%, timber 8%, steel 6%	Sri Lankan building sector study
Single Indian site (cumulative records)	Soil and sand 36%, bricks and masonry 31%, concrete 23%, steel 5%	GPSC presentation, 2017

B. Material wastage rates

Material-level studies express waste as a share of the quantity purchased or required. A Sri Lankan site study found steel wasted at about 4.7%, and cement, timber, sand, concrete and bricks at about 3% each (University of Peradeniya). A Kampala study found timber the most wasted (about 5%) and recommended a general allowance of 3% (Kechika, 2022). Indian estimating practice commonly adds allowances of roughly 1% to 3% for cement, 3% to 7% for steel, 5% to 10% for bricks and 10% to 15% for plaster (InfraLens summary of CPWD practice). These secondary sources should be checked against the CPWD manual before being cited as standards.

C. Causes of Waste

Studies of building sites repeatedly name the same groups of causes:

- Storage and handling: open storage, exposure to rain, damaged bags and breakage during unloading, ranked as the top factor for cement and steel waste in one Egyptian study (EIJEST).
- Site management and supervision: weak planning, over-ordering, poor sequencing and lack of a site waste plan (Jain, 2012, as cited in a ZJPAS paper).
- Workmanship and design: rework from errors, over-mixing, cutting of non-modular sizes and late design changes.

D. Research Gap

Most Indian figures are top-down estimates, and site-based studies with consistent categories and weighed data are few. This study adds a site-level categorization with percentage analysis using a single, repeatable protocol.

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III. METHODOLOGY

The study uses a cross-sectional site survey: waste is measured at source on active building sites, sorted into fixed categories, weighed, and expressed as a percentage of total waste by weight.

A. Site Selection

Sites are chosen to represent the common building types in the study area. The suggested sample is 8 to 12 sites, stratified as follows.

Table 3.1. Suggested site sample.

Stratum	Criteria	Suggested sites
Residential	RCC framed, 4 to 12 storeys	4
Commercial / institutional	RCC framed, 3 to 8 storeys	3
Small residential	Load-bearing or 1 to 3 storeys	3

Each site is visited at three construction stages (substructure, superstructure and masonry, finishing) so that stage-wise differences in waste composition are captured.

B. Waste Categorization

Waste is classified into ten categories, adapted from common C&D waste classifications used in the literature.

Table 3.2. Waste categories.

Code	Category	Typical sources on site
C1	Concrete and cement mortar	Spillage, left-over mix, formwork residue, demolition of faulty work
C2	Bricks and blocks	Breakage in handling, cutting for openings, over-ordering
C3	Tiles and ceramics	Cutting, breakage, wrong sizes
C4	Steel and reinforcement	Off-cuts, bending loss, rusted bars
C5	Timber and formwork	Shuttering damage, packing, off-cuts
C6	Plastics and packaging	Cement bags, pipe packaging, wrapping
C7	Plaster, gypsum and boards	Excess mixing, cutting, rework
C8	Glass and aluminium	Breakage, cutting
C9	Paint, adhesives and chemicals	Left-over, expired or spilled material
C10	Excavated soil and mixed / other	Basement and foundation excavation, unsorted debris

C. Data collection

1) Waste sorting and weighing. At each visit, one working week of waste is sorted by category into labelled bins and weighed on a platform scale (resolution 0.1 kg). Bulky items measured by volume are converted to mass using standard bulk densities.

2) Material records. Purchase, delivery and consumption records are collected for the main materials (cement, bricks, steel, tiles, sand) to estimate material wastage rates.

3) Site observation. A structured checklist records storage practice, cutting areas, reuse of off-cuts, segregation and disposal method, with dated photographs.

4) Interviews. A short questionnaire is given to the site engineer, supervisor and foreman on perceived causes of waste and current reduction measures.

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D. Calculations

The percentage share of each category i in the total waste of a site is:

$$P_i = (W_i / \Sigma W_j) \times 100, \quad j = 1 \ldots n$$

The waste generation rate per unit built-up area is:

$$WGR = \Sigma W_i / A_{bua} \quad (kg/m^2)$$

The material wastage percentage for a purchased material is:

$$MW = (Q_{purchased} - Q_{used\ in\ works}) / Q_{purchased} \times 100$$

Here W_i is the weighed mass of category i, n is the number of categories and A_bua is the built-up area completed in the survey period. Percentages are first computed per site and stage, then averaged across sites using a weighted mean (weights = total waste mass) and an unweighted mean, so that large sites do not hide small-site patterns.

E. Data Quality

Scale calibration is checked at the start of each visit. Mixed loads are sorted by hand before weighing. Categories contributing less than 1% of mass are reported but grouped with C10 for comparison.

IV. RESULTS AND ANALYSIS

Placeholder data. No field survey was supplied, so the figures below are a worked example with invented numbers (one hypothetical site, one survey week) that show how the analysis is laid out. Replace every value in Table 4.1 with your own weighed data before submitting; recalculate the percentage and rate columns by hand or in a spreadsheet using the formulas in Section 3.4.

A. Category-wise waste composition

In the worked example, bricks and blocks and concrete and mortar together make up 49% of the 12,500 kg of waste weighed.

Table 4.1. Illustrative composition for one site, one survey week.

Code	Category	Mass (kg)	Share of total (%)
C2	Bricks and blocks	3,250	26.0
C1	Concrete and cement mortar	2,875	23.0
C10	Excavated soil and mixed / other	2,250	18.0
C5	Timber and formwork	1,125	9.0
C7	Plaster, gypsum and boards	1,000	8.0
C3	Tiles and ceramics	875	7.0
C4	Steel and reinforcement	500	4.0
C6	Plastics and packaging	375	3.0
C8	Glass and aluminium	125	1.0
C9	Paint, adhesives and chemicals	125	1.0
	Total	12,500	100.0

B. Grouping by Management Route

Grouping categories by how they can be handled shows what is practical to divert from landfill.

Table 4.2. Waste grouped by management route.

Group	Categories	Share (%)	Handling route
Inert, crushable	C1, C2, C3, C10	74.0	Crush for fill, sub-base or recycled aggregate
Recyclable	C4, C5, C6, C8	17.0	Sell or return to vendors, reuse timber and off-cuts
Residual / hazardous	C7, C9	9.0	Separate disposal; paint and chemicals need safe handling

C. Waste Generation Rate

If 300 m² of built-up area was completed in the survey week, the rate is:

$$WGR = 12{,}500\ kg / 300\ m^2 = 41.7\ kg/m^2$$

This sits inside the 40 to 60 kg/m² planning range quoted for new construction in Section 1.1, but the real survey value should be compared with that range only after site data replace the example.

D. Material wastage and stage-wise analysis

For each major material, record quantity purchased, quantity used in works and the wastage percentage MW from Section 3.4. Repeat the composition table for each construction stage and compare the dominant categories: substructure waste is usually soil and concrete, masonry-stage waste is bricks, mortar and plaster, and finishing-stage waste is tiles, packaging, paint and off-cuts. Report the mean, range and standard deviation across sites for each category so that variation between sites is visible.

V. DISCUSSION

In block-and-RCC construction the waste stream is expected to be dominated by masonry, concrete and mortar, and the discussion should test whether the surveyed sites follow that pattern.

A. Comparison with Published Studies

Compare the surveyed shares with the benchmarks in Table 2.1. A masonry-heavy mix (bricks, concrete, mortar) resembles the Iraqi and Indian site figures, whereas a timber-heavy mix would match wood-frame studies such as the Malaysian one and would point to heavy formwork use or poor reuse. Differences in category definitions, treatment of excavated soil and the stage at which waste was sampled should be stated, because soil alone can shift every other percentage.

B. Waste Hotspots and Likely Causes

Table 5.1. Waste hotspots, likely causes and evidence to collect.

Hotspot	Typical cause	Evidence to collect
Bricks and blocks	Breakage in unloading and stacking, cutting for openings, over-ordering	Broken-unit count at delivery, stack photos
Concrete and mortar	Over-mixing, spillage, left-over batches, rework	Batch records, mixing area observation
Tiles and ceramics	Cutting, wrong sizes, no layout plan	Tile layout drawings, off-cut bins
Timber and formwork	Single-use shuttering, damage on stripping	Formwork reuse count
Plastics and packaging	Cement bags and wrappers discarded unsorted	Bag count against cement purchased
Steel	Cutting off-cuts, bend losses, rust	Bar bending schedule against actual cut lengths

C. *Influence of site conditions*

Discuss how building type, storey height, contractor experience, supervision level and season (especially monsoon exposure for cement and timber) relate to the measured differences between sites. With only 8 to 12 sites, relationships should be described as patterns and not as statistically proven effects.

D. *Cost and environmental implications*

Waste is paid for three times: as the material bought, as its handling, and as its disposal. Converting each category's mass into purchase value using local rates shows which categories carry the highest cost, which is often different from the heaviest category. Heavy inert fractions mainly matter for transport and landfill burden, while steel, timber and packaging matter for resale value.

VI. WASTE MINIMIZATION AND MANAGEMENT RECOMMENDATIONS

Measures are ordered by the waste hierarchy: prevent first, then reuse, recycle and, last, dispose.

Table 6.1. Minimization measures by project stage.

Stage	Measure	Targets category
Design and planning	Use modular dimensions, coordinate tile and block layouts, order from quantity take-offs with a stated allowance	C2, C3, C4
Procurement	Staged deliveries, supplier take-back of packaging and pallets, check quality at delivery	C2, C3, C6
Storage and handling	Covered, raised storage for cement; stacked bricks; mechanical handling for blocks	C1, C2, C6
On-site practice	Batch mixing to need, ready-mix where practical, central cutting yard with off-cut reuse, bar bending schedules	C1, C3, C4
Formwork	Reusable metal or plastic shuttering, planned reuse count	C5
Segregation	Labelled bins by category, an assigned waste area, weekly weighing and review	All
Recovery	Crush masonry and concrete for fill and sub-base, sell steel and cardboard, reuse timber for packing and temporary works	C1, C2, C4, C5
Management	A written site waste management plan, a named responsible person, waste targets in the contract	All

A site waste plan also supports regulatory compliance in India. The C&D Waste Management Rules, 2016 required waste generators to segregate and store C&D waste, with extra duties for large generators (summary). A published text of the Environment (Construction and Demolition) Waste Management Rules, 2025 supersedes them with effect from 1 April 2026 (rules text), so the current obligations should be confirmed against the notified 2025 Rules before the paper cites specific duties.

VII. CONCLUSION AND LIMITATIONS

The study sets out a repeatable site-survey protocol that sorts building-site waste into ten categories, weighs each category, and reports its percentage share, a generation rate per m² and material wastage percentages. In block-and-RCC building the expected pattern, to be confirmed with the survey data, is that masonry, concrete and mortar form the largest share by weight, so on-site handling, storage and mixing practice are the first places to act. Waste grouped by management route shows how much can be crushed for reuse, sold or must be disposed of separately.

Limitations to state in the final paper:

- The sample of 8 to 12 sites cannot represent all building types or regions.
- A one-week sampling window per stage may miss irregular large wastes such as formwork stripping.
- Weighing by hand sorting has measurement error, and volume-to-weight conversion adds uncertainty.
- Results exclude demolition and renovation waste and off-site losses.

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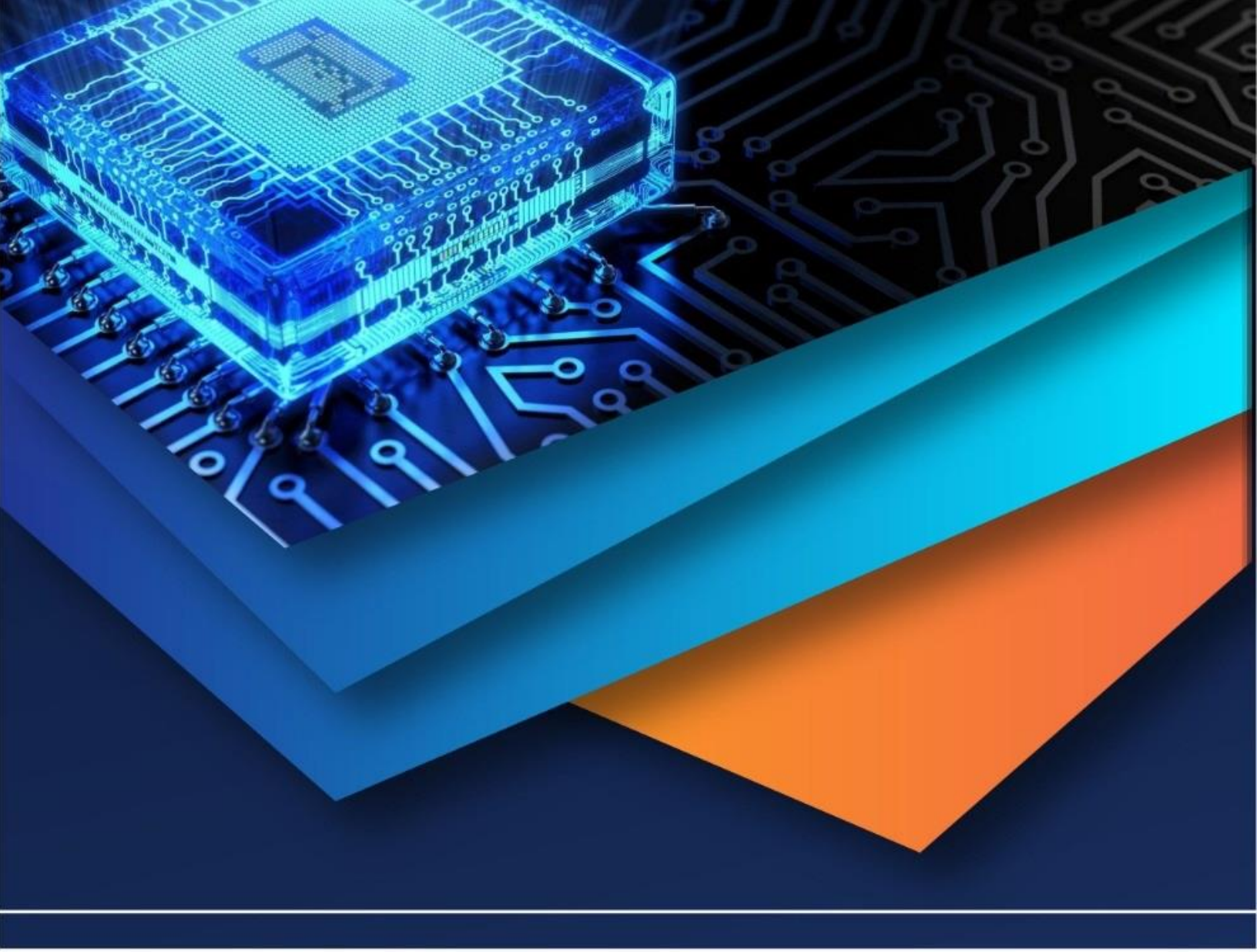
Future work could add cost valuation of waste, comparison of sites with and without a waste management plan, and tracking of waste after it leaves the site.

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