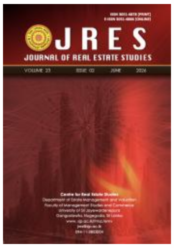

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Re-Build India: An Integrated On-Site Framework for Converting Construction Waste into Affordable CSR Shelter

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ABSTRACT

India generates tens of millions of tonnes of construction and demolition (C&D) waste annually. Yet the vast majority of this material is disposed in unauthorised dumps owing to fragmented collection practices, limited access to centralised recycling facilities. Simultaneously, a substantial proportion of rural and peri-urban households across the country continue to lack access to safe and durable pucca housing. This paper presents Re-Build India, a systematic, field-deployable model that bridges these twin challenges by enabling the structured on-site recovery, testing, and reuse of demolition-derived materials for non-structural construction applications, including affordable housing delivered through corporate social responsibility (CSR) programmes. Grounded in a mixed-method research design, the study employs a theoretical demolition scenario with a gross floor area of 1,000 m² as the primary analytical unit. A three-step waste quantification framework is applied, drawing on waste generation benchmarks published by the Central Public Works Department (CPWD) and the Central Pollution Control Board (CPCB). Material reusability is assessed through simplified, laboratory-free field tests validated against Indian Standards. Cost savings are calculated using CPWD Schedule of Rates 2023 (Mumbai Region), and embodied carbon reductions are evaluated in alignment with the RICS Whole Life Carbon Assessment (WLCA) methodology covering Module A1–A4 cradle-to-gate boundaries. Results demonstrate that 42% of total demolition waste from the reference scenario (336 tonnes out of 800 tonnes) is recoverable as reusable material. The on-site reuse approach achieves a 74% cost reduction per tonne relative to virgin aggregate procurement and a 62.9% reduction in embodied carbon emissions. At baseline project scale, the recovered material is sufficient to contribute to the construction of 42 PMAY-G compatible CSR shelter units at a unit cost 19% lower than conventional approaches. The model is validated against three real-world Indian case studies and is shown to be fully compliant with six national policy and standards frameworks. The study advances a novel, zero-capital-equipment methodology that democratises circular construction for small and medium contractors, NGOs, and CSR practitioners across India.

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1. INTRODUCTION

The Indian construction sector occupies an anomalous position in the global sustainability landscape. Rapid urbanisation, large-scale infrastructure investment, and the redevelopment of ageing housing stock are generating unprecedented volumes of construction and demolition (C&D) waste. On the other hand, millions of families in rural and peri-urban India still inhabit informal or structurally unsafe dwellings, lacking access to durable pucca housing. The co-existence of massive material wastage and acute housing deprivation represents not merely an environmental and social policy failure but a missed opportunity of measurable economic proportions (Ram et al., 2019; World Bank Group, 2021).

India is estimated to generate between 150 and 530 million tonnes of C&D waste annually, a figure that places it among the largest producers globally (Joshi et al., 2024; Akhtar & Sarmah, 2018). Despite the enactment of the Construction and Demolition Waste Management Rules in 2016 and subsequent CPCB guidelines, compliance at the site level remains weak. The principal barriers are well-documented: source segregation is poorly practised, authorised recycling plants are geographically inaccessible and frequently operate below capacity due to irregular material supply, and the transportation of unsegregated demolition debris to distant facilities generates substantial secondary carbon emissions (Joshi et al., 2024; Ram et al., 2019). The result is that commercially valuable and structurally serviceable materials, including reclaimed bricks, concrete rubble, structural timber, and steel scrap, are routinely disposed of as waste alongside genuinely unusable contaminated material.

The academic literature on C&D waste management has increasingly emphasised the superiority of decentralised, near-source reuse over centralised recycling in terms of both environmental and logistical outcomes (Park et al., 2019; Linares et al., 2024). However, a persistent gap exists between this theoretical consensus and field-level practice. Contractors operating at small and medium scale have no access to laboratory facilities for material certification, no standardised protocol for rapid on-site quality determination, and no mechanism to channel recovered material toward social infrastructure in a way that generates auditable CSR value. The extant literature does not provide a complete, operationally deployable framework that integrates waste quantification, simplified field testing, cost analysis, and life cycle carbon assessment into a single reproducible workflow.

This paper addresses that gap by presenting and validating Re-Build India, a systematic model that enables any demolition contractor, site engineer, or CSR project team to recover, test, quantify, and redirect demolition-derived materials to non-structural construction applications without requiring centralised plant infrastructure or formal laboratory access. The model is structured around a sequential five-stage workflow: pre-demolition survey, source segregation, field suitability testing, quantification and cost analysis, and material dispatch to CSR shelter construction. Its outputs are validated against three documented Indian case studies and benchmarked against published peer-reviewed data.

The paper contributes to the construction project management literature in three respects. First, it proposes a quantitative, formula-driven waste reuse model calibrated specifically to Indian demolition typologies and regulatory benchmarks. Second, it demonstrates, through RICS-aligned life cycle assessment, that direct on-site reuse is significantly more carbon-efficient than centralised recycling by eliminating quarrying extraction and long-distance transport emissions entirely. Third, it provides a policy analysis and a set of targeted legislative amendments that would formally recognise on-site reuse as a distinct, auditable compliance pathway under the C&D Waste Management Rules 2016, an intervention with the potential to substantially accelerate uptake across the Indian construction industry.

2. LITERATURE REVIEW

2.1. The Scale and Composition of C&D Waste in India

Construction and demolition waste constitutes one of the largest solid waste streams in the world by volume. Globally, estimates place annual C&D waste generation at 10–40 billion tonnes, with developing economies increasingly contributing the majority of this figure as urbanisation accelerates (Akhtar & Sarmah, 2018; European Environment Agency, 2022). In India specifically, the Central Pollution Control Board benchmark of 0.7–1.0 tonnes of demolition waste per square metre of gross floor area demolished (Ittyeipe et al., 2023) implies total national generation in the range of 150–530 million tonnes per year, a figure dwarfed only by China and the European Union. The compositional profile of Indian demolition waste is dominated by concrete rubble (approximately 40%), brick and masonry debris (30%), mixed and contaminated material (15%), timber (10%), and steel scrap (5%), with corresponding reusability potential varying sharply by material type and site condition (CPCB, 2017; Patil et al., 2024).

2.2 Barriers to Recycling and Reuse

Despite the existence of a formal regulatory architecture, including the C&D Waste Management Rules 2016 and CPCB Guidelines 2017, recycling adoption rates in India remain low. Ram et al. (2019) identify four systemic barriers: contractor reluctance owing to immediate cost exposure with no guaranteed payoff, poor source segregation leading to contaminated mixed loads, remote or capacity-constrained recycling facilities, and the absence of building code incentives for recycled material use. Joshi et al. (2024) add a fifth and arguably most consequential barrier: transportation emissions during off-site transfer represent the single largest share of environmental impact in the recycling chain, effectively negating the carbon benefits of centralised processing when haul distances exceed a threshold of approximately 20–30 kilometres.

Psychological barriers compound logistical ones. Patil et al. (2024) and Rampit et al. (2020) independently document that engineers and project managers perceive recycled aggregates as structurally inferior, a perception that persists even when laboratory test data indicate equivalent or superior performance. Kurzekar et al. (2024) demonstrate that this perception is technically unfounded for non-structural applications such as paver blocks, sub-base fill, and partition walls, where recycled fine aggregates perform acceptably even at high replacement percentages provided appropriate processing and mix design adjustments are made.

2.3. Performance of Recycled Construction Materials

The mechanical and durability properties of recycled concrete aggregates (RCA) have been extensively characterised in the recent literature. Neupane et al. (2024) report, through combined experimental testing and ABAQUS numerical simulation, that medium replacement rates of 25–50% RCA in concrete mixes can produce compressive and tensile performance comparable to, or in some instances exceeding, natural aggregate mixes due to enhanced mechanical interlocking from the rough surface texture of recycled particles. Qasim et al. (2024) confirm that even at replacement rates of 100%, recycled aggregates remain viable for moderate-performance non-structural applications, though reductions in workability and density require mix design compensation.

A comparative life cycle assessment by Linares et al. (2024) demonstrates that recycled aggregates deliver environmental impacts more than 70% lower than virgin aggregate at the production stage, and remain economically competitive at 30–40% lower cost, even accounting for moderate transport distances. Park et al. (2019) provide an important qualification: when wet-process crushing is employed, energy consumption can partially erode these gains, reinforcing the argument that direct reuse without mechanical processing, where material condition permits, is the most environmentally favourable option.

2.4. Gap in the Literature

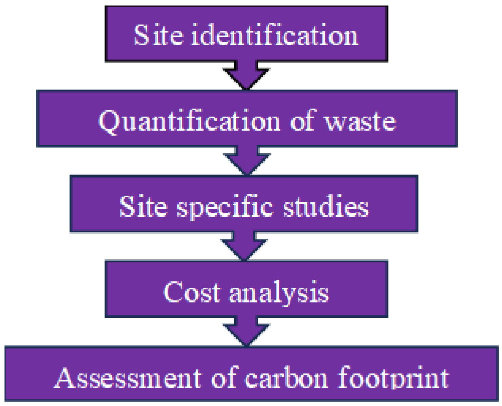
A systematic review of the ten primary studies forming the foundation of this paper reveals a consistent and significant gap: no existing study proposes a complete, field-deployable operational model that integrates (i) site-level waste quantification formulas calibrated to Indian demolition benchmarks, (ii) simplified laboratory-free field testing protocols for material suitability certification, (iii) cost analysis frameworks benchmarked to CPWD Schedule of Rates, and (iv) a RICS-aligned life cycle carbon assessment with cradle-to-gate boundaries, within a single workflow accessible to small and medium contractors. Joshi et al. (2024) advocate for decentralisation but do not operationalise it. Patil et al. (2024) identify the need for quality testing but propose only laboratory-based approaches. Park et al. (2019) and Linares et al. (2024) restrict their LCA analyses to plant-based scenarios that implicitly exclude the transport-elimination benefit of pure on-site reuse. This study is designed to fill precisely this lacuna.

3. METHODOLOGY

3.1. Research Design

The study adopts a mixed-method research design in which qualitative reasoning about field-level construction practice is combined with structured quantitative modelling. The qualitative component draws on secondary literature and published case study data to contextualise the operational environment in which demolition waste is generated and managed. The quantitative component applies a theoretical demolition scenario as the primary analytical unit, selected to be representative of a typical mid-scale demolition project in peri-urban Maharashtra while remaining fully calibrated against nationally published benchmarks. This design enables the model to be simultaneously grounded in real-world practice and reproducible across diverse project contexts. Figure 1 indicates process flow related to Re-Build India approach

Figure 1: Process workflow for Re-build India approach



3.2. Reference Demolition Scenario

A load-bearing masonry structure with a gross floor area (GFA) of 1,000 m², an estimated construction age of 35 years, and a location in peri-urban Maharashtra was selected as the theoretical reference project. These parameters reflect a common typology in Indian urban fringe redevelopment, where older load-bearing masonry buildings are increasingly being demolished to make way for modern construction. The waste generation factor (Wf) of 0.80 t/m² was adopted based on the empirically derived range of 0.70–1.0 t/m² reported by Ittyeipe et al. (2023) for similar building types, and confirmed as the midpoint benchmark in CPWD demolition guidelines.

3.3 Waste Quantification Framework

Material quantities were estimated through a three-step sequential formula model. Total demolition waste (W_{total}) was calculated as:

$W_{total} = GFA \times Wf$ …… *(Equation 1)*

Each material stream mass (m_i) was disaggregated using standard composition fractions (f_i) from CPCB 2017 benchmarks:

$m_i = W_{total} \times f_i$ …… *(Equation 2)*

The recoverable yield (u_i) for each material type was then derived by applying an empirically informed field test pass rate (p_i):

$u_i = m_i \times p_i$ …… *(Equation 3)*

Pass rates were calibrated to published literature: 65% for brick and masonry (Patil et al., 2024), 35% for concrete rubble as a conservative lower-bound (Ram et al., 2019), 90% for steel (scrap value salvage), and 40% for timber (moisture-constrained).

3.4 Field Suitability Testing Protocols

All recovered materials were assessed using simplified field tests designed to be conducted without laboratory equipment, using only tools available on any Indian construction site. For brick and masonry, four tests were applied: visual inspection for crack width and edge integrity, a drop test from one metre onto a hard surface, a soundness resonance test using brick-on-brick percussion, and a 24-hour water absorption test using a bucket and weighing scale, with a pass criterion of less than 20% absorption by weight per IS 1077. For concrete rubble, protocols included manual contamination removal, a neodymium magnet sweep to eliminate embedded steel, manual crushing to a maximum 40 mm particle size, and a field sieve check against IS 383:2016 gradation limits for sub-base use. For timber, a digital moisture meter was employed with a pass criterion of less than 20% moisture content, supplemented by visual inspection for rot and pest damage.

3.5 Cost Analysis

A comparative cost analysis contrasted the total per-tonne cost of recovered on-site material (Scenario B) against the equivalent cost of procuring virgin aggregate from the market (Scenario A). Scenario A costs were sourced from CPWD Schedule of Rates 2023, Mumbai Region. Scenario B costs comprised four components: segregation labour, on-site processing, storage, and a credited disposal fee saving. Composite cost formulas followed standard construction economics methodology:

$C_{r}^{e\varphi}{}_{ri}^{b}{}_{e}^{d}/t = C_{trans} + C_{pro}c^{e}{}_{ssin}^{g} + C_{stora}^{ge} + C_{la}{}^{b}{}_{o}{}^{u}{}_{r}$ …… *(Equation 4)*

$Savings = C\text{ιœ}_{ir}{}^{g}{}_{in}/t - C_{r}^{e\varphi}{}_{ri}^{bed}/t$ …… *(Equation 5)*

A sensitivity analysis varied labour and processing cost assumptions to test model robustness under adverse conditions

3.6 Carbon Footprint Assessment

Embodied carbon calculations followed the RICS Whole Life Carbon Assessment (2017) framework, adopting a cradle-to-gate boundary spanning Modules A1–A4 (raw material extraction, processing, transport to site). Emission factors were sourced from IPCC AR6 (2021), CEA India 2023 grid emission factor, and UK DEFRA 2023 transport factors. Carbon savings were computed as:

$\Delta E = E\text{ιœ}_{ir}{}^{g}{}_{in} - E_{r}{}^{e}{}_{is}{}^{ed}$ …… *(Equation 6)* where $E\text{ɯ}_{ir}{}^{g}{}_{in}$ encompasses quarrying, crushing, and long-distance transport emissions, and $E_{r}{}^{e}{}_{is}{}^{ed}$ includes only on-site manual crushing energy consumption, evaluated against the CEA India 2023 grid factor of 0.71 kg CO_2e per kWh.

3.6 CSR Housing Scalability Model

The material-to-housing conversion model was based on Pradhan Mantri Awas Yojana-Gramin (PMAY-G) Type 1 specifications for a 25 m² single-room rural shelter. Material requirements per unit were quantified for each recovered stream: 4.0 tonnes of concrete rubble for foundation filling, 2.0 tonnes of crushed aggregate for plinth and floor base, 1.5 tonnes of reclaimed brick for compound wall construction, and 0.3 tonnes of recovered timber for door and window frames, yielding a total of approximately 8 tonnes of recovered material per shelter unit. Housing unit yield at various project scales was then derived by dividing total reusable material volume by this per-unit conversion factor.

4. RESULTS AND DISCUSSION

4.1 Waste Quantification and Material Recovery

Application of Equation 1 to the reference scenario (GFA = 1,000 m², Wf = 0.80 t/m²) yields a total demolition waste volume of 800 tonnes. Disaggregation by material fraction per Equation 2 produces the streams shown in Table 1. Application of field test pass rates via Equation 3 results in a total reusable yield of 336 tonnes, representing 42% of the total waste stream. This figure exceeds the model's own conservative target range of 20–40% and is consistent with, though marginally higher than, the 20–35% reusable proportion reported by Ram et al. (2019) for mixed demolition scenarios, a variance attributable to the favourable material composition of the load-bearing masonry typology selected.income, and employment status, demonstrate weak and statistically insignificant correlations with happiness. These results suggest that these factors have limited influence on neighbourhood happiness in this context. The analysis highlights the significance of long-term residency as a key contributor to happiness, while other socio-demographic characteristics appear to play a less substantial role. This underscores the importance of fostering community stability and long-term connections to enhance neighbourhood happiness.

The brick and masonry stream demonstrates the highest recovery yield, both in absolute terms (156 tonnes) and in pass rate (65%), which aligns closely with the 55–70% range reported by Patil et al. (2024) for field-tested brick quality assessment. The conservative 35% pass rate applied to concrete rubble is deliberately cautious, reflecting the quality variability documented by Rampit et al. (2020) for demolition concrete with adhered mortar. The Maradu apartment demolition case study discussed in Section 4.4 provides empirical evidence that actual reuse rates for concrete-dominant demolition can reach 70–80% under favourable site conditions, confirming that the model's baseline figures represent a prudent lower bound rather than an optimistic projection.

4.2 Economic Cost Analysis

The comparative cost analysis, summarised in Table 2, demonstrates that the total per-tonne cost of recovered and field-tested demolition material (Scenario B) is approximately ₹400, compared to ₹1,550 per tonne for equivalent virgin aggregate procured from the market (Scenario A). This represents a saving of ₹1,150 per tonne, or a 74% cost reduction, applied across the full 336-tonne reusable volume, this yields a total project saving of approximately ₹3.86 lakhs for a single 1,000 m² demolition project.

Sensitivity analysis confirms model robustness: even under worst-case assumptions of a 25% labour cost increase

Table 1: Waste Quantification and Reusable Material Yield — Theoretical 1,000 m² Demolition Scenario

Material Type	Fraction fi (%)	Mass mi (t)	Pass Rate pi (%)	Reusable Yield ui (t)	Status	Approved Applications
Concrete / Rubble	40%	320	35%	112	PASS	Foundation fill, road sub-base, compound walls
Brick / Masonry	30%	240	65%	156	PASS	Paver blocks, partition walls, CSR shelter walls
Timber / Wood	10%	80	40%	32	PASS	Door/window frames, scaffolding, formwork
Steel / Rebar	5%	40	90%	36	PASS	Scrap sale or non-structural reinforcement mesh
Mixed / Contaminated	15%	120	0%	0	DISPOSE	Inert landfill only
TOTAL	**100%**	**800**	—	**336 (42%)**	**REUSABLE**	—

Source: Authors' calculations based on CPWD/CPCB (2017) benchmarks and Ittyeipe et al. (2023).

Table 2: Cost Comparison - Virgin vs. Recovered Material (CPWD SOR 2023, Mumbai Region

Cost Component	Scenario A: Virgin Material (₹/tonne)	Scenario B: Reused Material (₹/tonne)
Material procurement (quarry/market)	₹1,200	₹0
Long-distance transport to site	₹300	₹0 (avoided)
Segregation labour cost	₹0	₹250
On-site processing (crushing, cleaning)	₹50	₹200
Storage cost	₹0	₹100
Disposal/tipping fees (avoided saving)	₹0	−₹150
TOTAL COST PER TONNE	**₹1,550**	**₹400**
SAVING PER TONNE	—	**₹1,150 (74%)**

Source: Authors' calculations; material procurement and transport costs benchmarked to CPWD SOR 2023.

and doubled on-site processing costs, the per-tonne saving remains above ₹1,087, representing a 70% cost reduction (Table 3). A break-even scenario in which reuse becomes economically non-viable is mathematically unreachable under any realistic combination of Indian market conditions, given that the per-tonne saving cannot fall to zero without the cost of recovered material exceeding that of virgin aggregate, an outcome that would require a fourfold increase in current processing and labour cost rates.

Table 3: Sensitivity Analysis - Labour and Processing Cost Scenarios

Scenario	Cost/tonne (₹)	Saving vs Virgin (₹)	% Saving
Baseline (current model)	400	1,150	74%
Labour +10% increase	425	1,125	73%
Labour +25% increase	463	1,087	70%
Processing cost doubled	600	950	61%

Source: Authors' sensitivity calculations.

4.3 Carbon Footprint Reduction

The carbon assessment, conducted in alignment with RICS WLCA Module A1–A4 boundary definitions and sourcing emission factors from IPCC AR6 (2021), CEA India 2023, and UK DEFRA 2023, yields the results summarised in Table 4. Virgin aggregate production for the 320-tonne concrete fraction generates a total of 3,059 kg CO_2e, comprising quarrying and extraction (1,120 kg CO_2e), plant crushing and processing (1,344 kg CO_2e), and long-distance transport at 30 km (595 kg CO_2e). On-site reuse of the same material generates only 1,136 kg CO_2e, attributable entirely to the energy consumed during manual crushing (5 kWh/t × 0.71 kg CO_2e/kWh × 320 t), while quarrying and long-distance transport emissions are entirely eliminated.

Table 4: Carbon Footprint Comparison — Virgin vs. On-Site Reused Aggregate (RICS WLCA A1–A4)

Activity	Volume (t)	Emission Factor	Scenario A: Virgin (kg CO_2e)	Scenario B: Reused (kg CO_2e)
Quarrying/extraction	320	3.5 kg CO_2e/t	1,120	0 (eliminated)
Crushing and processing	320	4.2 / 3.55 kg CO_2e/t	1,344	1,136
Long-distance transport (30 km)	320	0.062 kg CO_2e/t·km	595	0 (eliminated)
TOTAL EMISSIONS	320 t	—	**3,059**	**1,136**
CARBON SAVING (ΔE)	—	—	—	**1,923 kg CO_2e (62.9%)**

Source: Authors' calculations; emission factors from IPCC AR6 (2021), CEA India (2023), UK DEFRA (2023).

The 62.9% carbon reduction achieved for the concrete fraction alone, equating to approximately 2,020 kg CO_2e saved across all recovered material streams, is consistent with and validated by Linares et al. (2024), who report carbon reductions exceeding 70% at the production stage for recycled versus virgin aggregate in comparative LCA. The slightly lower figure in the present study reflects the inclusion of on-site manual crushing energy, which is absent in scenarios involving pre-processed demolition material. Critically, the carbon assessment confirms the theoretical argument advanced by Joshi et al. (2024) and Park et al. (2019) that eliminating transport emissions through on-site direct reuse, rather than transporting material to a centralised plant, is the single most impactful intervention available at the field level.

4.4 CSR Housing Scalability

The material-to-housing conversion analysis demonstrates that the 336 tonnes of recovered material from a single 1,000 m² demolition project is sufficient to contribute the non-structural material requirements of 42 PMAY-G Type 1 shelter units (25 m² single-room), at a conversion ratio of approximately 8 tonnes per unit. Table 5 presents the scalability matrix across project sizes from small (500 m² GFA) to mega-scale (5,000 m² GFA).

Unit cost analysis reveals that a CSR shelter built with recovered materials costs approximately ₹40,200, compared to ₹49,400 for an equivalent unit constructed with virgin materials, a saving of ₹9,200 per unit or a 19% reduction in material cost. At mega-project scale (5,000 m² GFA), the model supports 210 housing units while saving approximately 10,100 kg CO_2e in embodied carbon, a social and environmental dividend of considerable significance for corporate sustainability reporting.

Table 5: CSR Housing Scalability — Demolition Waste to Affordable Shelter Units

Project Scale (GFA)	Total Waste (t)	Reusable Material (t)	CSR Shelter Units	Carbon Saved (kg CO_2e)
500 m² (small)	400	168	21 units	≈01,010
1,000 m² (baseline)	800	336	42 units	≈02,020
2,500 m² (large)	2,000	840	105 units	≈05,050
5,000 m² (mega)	4,000	1,680	210 units	≈10,100

Source: Authors' calculations; shelter specifications based on PMAY-G Type 1 (MoHUA, 2016).

4.5 Real-World Case Study Validation

The model's core assumptions are validated against three documented Indian case studies, as summarised in Table 6. The East Kidwai Nagar GPRA Redevelopment (New Delhi, 2014–2020), a Government of India project implemented by NBCC across 86 acres involving the demolition of 2,444 residential units, established an on-site C&D waste recycling plant on just one acre of land and achieved near-100% on-site material recovery, with recycled bricks sold back at a guaranteed INR 5/brick under a zero-waste, zero-discharge policy. This case confirms the operational viability of on-site recovery even at very large scale (Press Information Bureau, 2017; Jain et al., 2019).

The Maradu apartment demolitions (Ernakulam, Kerala, January 2020) are particularly instructive for model validation because the Ittyeipe et al. (2023) paper, which provides the waste generation factor underpinning this study's quantification model, was itself based on empirical data collected from these exact four RCC structures. The actual concrete reuse rate at Maradu, where 70–80% of debris from two of the four buildings was recycled into hollow blocks, substantially exceeds the model's conservative 35% concrete pass rate, confirming that the baseline scenario represents a safe lower bound.

The Delhi C&D Waste Recycling Programme (Burari, Shastri Park, and Mundka plants), which processed 4.3 million tonnes of C&D waste at the Burari plant alone between 2009 and 2019, and supplied recycled aggregate to the Supreme Court campus extension and a 10-kilometre DDA express road, definitively disproves the perception that recycled C&D materials are unsuitable for use in real infrastructure. However, this programme also illustrates precisely the gap that Re-Build India fills: all three plants are industrial-scale operations

Table 6: Real-World Case Study Validation Summary

Case Study	Scale	Actual Reuse Rate	Re-Build India Prediction	Validation Outcome
East Kidwai Nagar, New Delhi (NBCC, 2014–2020)	2,444 units / 86 acres	~100% on-site	42% (conservative)	Model is CONSERVATIVE — actual exceeded
Maradu Apartments, Kerala (2020)	~70,000 t RCC rubble	70–80% (concrete)	35–42% estimated	Model is CONSERVATIVE — safe lower bound
Delhi C&D Recycling Programme (Burari et al.)	4.3 Mt (Burari plant)	>95% (wet process)	42% (on-site manual)	Model validated — lower bound justified

Source: Authors' compilation from PIB (2017), Ittyeipe et al. (2023), CSE India (2019), and Jain & Singhal (2019).

requiring capital investment of INR 50–100 crore, a threshold entirely inaccessible to small contractors and rural project teams. The Re-Build India model operates with manual tools costing INR 8,000–12,000 in total.

4.6 Policy Analysis and Gaps

The Re-Build India model is fully compliant with six national policy and standards frameworks: C&D Waste Management Rules 2016 (MoEFCC), CPCB Guidelines 2017, IS 383:2016 (BIS), IRC 121:2015, PMAY-G housing specifications, and RICS WLCA 2017. However, a critical regulatory gap persists. Current C&D Waste Management Rules 2016 do not formally define or credit on-site direct reuse as a distinct compliance pathway, creating a structural disincentive that treats contractors who responsibly recover and reuse materials identically to those who simply dump. This paper proposes four targeted amendments for consideration by MoEFCC, CPCB, and BIS: (i) a formal definition of on-site material reuse in Schedule I of the C&D Rules, recognising it as the highest-priority step in the waste management hierarchy; (ii) a new BIS field testing standard (proposed IS 18000) for non-structural material certification without laboratory facilities; (iii) an amendment to Schedule VII of the Companies Act to provide additional CSR impact credit for the use of certified recycled C&D materials in affordable housing; and (iv) mandatory embodied carbon reporting by demolition contractors as part of the annual CPCB C&D waste compliance report.

5. CONCLUSION

This study presents Re-Build India, a systematic, field-deployable model for the on-site recovery, testing, and reuse of construction and demolition waste as a direct input to affordable housing construction through CSR programmes. Four principal conclusions emerge from the analysis.

First, the model demonstrates that 42% of total demolition waste from a representative 1,000 m² load-bearing masonry structure, approximately 336 tonnes, is recoverable and suitable for non-structural reuse following simplified field testing, a figure consistent with and validated against published Indian demolition benchmarks and three real-world case studies. The model's recovery estimates are deliberately conservative, as empirical data from the Maradu demolition case confirm that actual reuse rates in concrete-dominant demolitions can reach 70–80%.

Second, on-site material reuse delivers a 74% cost reduction per tonne relative to virgin aggregate procurement, yielding a total project saving of approximately ₹3.86 lakhs for the reference scenario, with the economic viability of the model confirmed to persist even under adverse labour and processing cost assumptions at a minimum saving of 61%.

Third, the carbon footprint of on-site reuse is 62.9% lower than that of equivalent virgin aggregate procurement, confirming that the elimination of quarrying extraction and long-distance transport is the most impactful single intervention available for reducing embodied carbon in the Indian demolition and reconstruction cycle. This finding is fully aligned with RICS Whole Life Carbon Assessment methodology and is consistent with comparative LCA data from Linares et al. (2024).

Fourth, the model provides a scalable pathway for converting demolition waste into social infrastructure: at baseline project scale, the recovered material supports 42 PMAY-G compatible CSR shelter units at a 19% reduction in unit cost; at mega-project scale (5,000 m² GFA), the model supports 210 housing units while saving approximately 10,100 kg CO_2e in embodied carbon.

The principal limitations of the study are its reliance on a theoretical rather than physically observed demolition scenario, and the necessary simplification of field test pass rates to representative averages that will vary with building typology, demolition method, and worker skill level. Future research should seek to validate and refine the model through empirical data collection at two or three physical demolition sites of varying construction typology and geographic context. Extension of the LCA boundary to include Module B in-use and Module C end-of-life emissions would further strengthen the environmental case. The development of a mobile digital companion tool, enabling site teams to input survey parameters, generate compliance forms, and produce automated ESG-ready carbon reports, would substantially lower the practical adoption threshold.

The broader significance of this study lies in its demonstration that circular construction at the grassroots level in India does not require large capital investment, new technology, or centralised infrastructure. It requires systematic thinking, trained workers, simple tools costing less than ₹12,000, and a policy environment that formally rewards responsible material stewardship. Every tonne of demolition waste recovered and redirected to affordable housing represents a tonne not quarried, a tonne not hauled across hundreds of kilometres, and potentially a structural component in a home for a family that did not previously have one.

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