Turning demolition waste into sand and stone: a short account of a mobile sensor-controlled recycling line

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> **About this version.** This is a shortened, plain-language preprint of a full paper submitted to *Periodica Polytechnica Civil Engineering* on 15 November 2026, Submission ID 47575, currently under peer review. It reports the same system, design values and simulated numbers — no number changed. The full paper (about 11,700 words) is the version under review. It is a preprint: it has **not** been peer reviewed. It is prepared for posting on engrXiv. If the journal paper is published, this preprint will be updated with its DOI.

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> **AI disclosure.** AI assistance was used in drafting this manuscript. The author is responsible for every claim in it.

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> **Competing interest.** Copyright Registration Certificate No. 8052/2026/QTG (13 August 2026) for the work described here is jointly held by Duong Van Sinh and Bui Thanh Khanh. That certificate is a copyright registration, not a patent grant. No other competing interest is declared.

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Abstract

Demolition waste is usually landfilled or dumped, while natural river sand grows scarce. Crushing demolition waste alone rarely yields stable aggregate, and its grading drifts with the feedstock. This short paper describes a mobile, sensor-controlled recycling line: vibrating feeder with manual picking, belt magnet, jaw crusher and vertical-shaft impactor, multi-deck screen with oversize recirculation, and water-cyclone washing with recirculation and sludge recovery. Sensors for flow, turbidity and particle size adjust feed, rotor speed, water and screening. The design reference is about 100 tonnes per day (12.5 tonnes per hour on a single 8-hour shift), with 20/10/5 mm screen apertures, a 75 mm jaw setting, a 60 m/s rotor tip speed and a 63 µm cyclone cut. It targets sand 0–5 mm and stone 5–10 and 10–20 mm; a 20–40 mm band is claimed in the dossier, but the reference line as described is not configured to produce it — that would need an additional screen deck. No pilot has been run. No measured product properties, pilot throughput, energy use, or water use are reported — none exist in the dossier. All performance figures are simulated estimates: about 90.3 tonnes per day of saleable product from 100 tonnes of feed, simulated electricity use of 3.7 kWh per tonne of feed, fresh make-up water of 0.16 m³ per tonne of feed at 93% recirculation, and simulated 28-day concrete strengths of 36.0 MPa at 20% coarse replacement and 27.0 MPa at 100% coarse replacement, against a 38.0 MPa reference.

1. Why crushing demolition waste is not enough

A demolished building produces tonnes of concrete, brick, mortar and tile, mixed with wood, plastic, plaster, glass and steel — usually landfilled or dumped. In Ho Chi Minh City, where this system was specified, construction waste is projected at 15,000–20,000 tonnes per day. The material thrown away is mostly mineral, while the sand it could replace is under pressure: global aggregate production reached 40 billion tonnes in 2014, up from 21 billion in 2007.

A jaw crusher alone reduces size, but not the problems that make recycled aggregate unreliable: adhered cement paste, fine dust, weak particles — soft brick, plaster, weathered mortar — and other light contaminants. And because the feedstock changes with every building demolished, the grading of the output drifts from load to load.

Published work agrees: adhered paste, higher water absorption, lower density and variability limit recycled aggregate (Tam et al., 2018; Silva et al., 2014), while washing improves it, with concrete of comparable strength at up to about 20% replacement (Ferriz-Papi et al., 2026).

2. What the line does

The system is a modular line on a mobile or semi-mobile frame, so it can be set up near a demolition site, a transfer yard or an urban renewal site, rather than hauling waste to a fixed plant. Quality checking is listed as a final step, but the dossier states no test methods, limits or standard for it, so it is not evidence that any check has been passed.

Mixed demolition waste is loaded into a vibrating feed hopper and passes a manual picking station, where wood, plastic and plasterboard are removed by hand — plaster (gypsum) matters most, since it can cause sulfate problems. The material then passes under a belt magnet, which removes iron and steel, protecting the crushers.

The pre-treated material enters a jaw crusher at a nominal closed-side setting of 75 mm; at that setting the jaw product top size is about 95 mm, inside the assumed 100 mm maximum feed size of the vertical-shaft impactor (VSI) class used here — to be confirmed at commissioning. Material then goes to the VSI (or equivalent impact crusher), at a nominal rotor tip speed of 60 m/s. Impact crushing breaks particles along their weakest planes, which tends to remove weak particles and strip adhered cement paste, and produces a more cubic particle shape.

After fine crushing, the material passes over a three-deck vibrating screen (nominal apertures 20, 10 and 5 mm), which separates the stream into 0–5 mm, 5–10 mm and 10–20 mm; oversize is recirculated to the fine crusher until it reaches the target size. Screened sand and stone are then washed in a water cyclone (a screw washer or washing drum is the stated alternative), to remove fine dust, adhered paste and remaining light contaminants. The hydrocyclone cut is set nominally at 63 µm, the fines threshold in EN 12620. Wash water is not discharged: it passes through a settling tank or sludge press, the fine sludge is recovered, and the water is recirculated.

A central controller receives signals from material-flow, wash-water turbidity and particle-size-distribution sensors, with conveyor-load and moisture sensors also named, and adjusts feed rate, rotor speed, recirculation and wash-water flow. It is a feedback loop: too many fines, and the controller can slow the feed or change the rotor speed; turbid wash water, and it can increase the wash-water flow — holding the grading band and cleanliness steady even when the feedstock changes. The dossier describes this control as a design, giving no sensor models, sampling rates, control algorithms, set points or measured record of the loop holding a grading band. No published study of such a closed-loop grading control for mixed demolition waste was found. The control system is therefore a specified design with a stated validation test, not a demonstrated capability.

Four products are claimed: recycled sand 0–5 mm for mortar and concrete; recycled stone 5–10 mm and 10–20 mm for concrete aggregate and road base; and recycled stone 20–40 mm for road base, fill and other uses. The reference configuration produces three of them — sand and stone up to 20 mm. The 20–40 mm band is a claimed band the reference line is not configured to produce; producing it would need an additional screen deck, and no 20–40 mm outlet is claimed for the reference line. These are design bands, not measured grading results.

3. What the simulation found

No pilot has been run, so no measured performance exists: every value here is simulated. The simulation is a steady-state calculation at the reference configuration (about 100 t/day, single 8-hour shift, 12.5 t/h feed), assuming a feedstock of 55% concrete, 30% brick and masonry, 10%

mortar and 5% tile and stone by mass; the dossier gives no feedstock survey. Manual picking is assumed to remove 2% of the feed, the belt magnet 1.5% as steel, and the screen to separate at 90% efficiency.

Simulated mass balance. At the 100 t/day reference the line produces about 90.3 t/day of saleable product — 17.4 t of sand, 25.5 t of 5–10 mm stone and 47.4 t of 10–20 mm stone — with 6.2 t/day of sludge and filler, 2.0 t/day of picking rejects and 1.5 t/day of steel. At 85% utilisation, allowing for stoppages and moves, the effective throughput is about 85 t/day of feed and 76.8 t/day of product, or about 21,250 t of feed and 19,200 t of product over a 250-day year.

Simulated grading and properties. The simulated sand has a fineness modulus of about 2.9, a coarse sand: 100% passing 5 mm, 80% at 2.5 mm, 38% at 0.63 mm and 5% at 0.063 mm after washing — washing removes about half of the fines below 0.063 mm, from about 10% to 5%. The two coarse fractions sit inside the EN 12620 Gc85/20 envelope, passing 99% at their upper sieve and 8–10% at their lower sieve; that carryover is the assumed 90% screening efficiency, not a measured misplacement.

Fraction (simulated)	**Oven-dry density (kg/m³)**	**Water absorption, washed / unwashed (%)**	**Fines <0.063 mm, washed (%)**
Sand 0–5 mm	**2,150**	**9.0 / 10.5**	**5.0**
Stone 5–10 mm	2,200	8.0 / 9.5	1.0
Stone 10–20 mm	2,280	7.0 / 8.5	0.5

Washing lowers absorption by about 1.5 percentage points. Simulated chloride of 0.01–0.03% meets the EN 12620 limit of 0.03% for reinforced concrete but not the 0.01% limit for prestressed concrete; acid-soluble sulfate of 0.10–0.18% meets the strictest category AS0.2 (at most 0.2%); total sulfur of 0.5–0.8% meets the 1% limit. With 5% fines the simulated sand falls in EN 12620 fines category f6 (at most 6%), not f3 (at most 3%) as normally specified for concrete sand.

Simulated energy, water and carbon. Simulated electricity, by equipment, is jaw crusher 0.6, VSI 2.0, screens and conveyors 0.5, pumps 0.4 and auxiliaries 0.2 kWh per tonne of feed — 3.7 kWh/t of feed and 4.1 kWh/t of product in total. Diesel is 0.8 L/t of feed for the loader and site handling, excluding off-site transport. Water is a closed circuit: 2.5 m³ per tonne of washed product circulates (226 m³/day) with 93% recirculation, so fresh make-up water is 0.16 m³/t of feed (16 m³/day), or 0.18 m³/t of product. Simulated carbon is 4.6 kg CO2-eq/t of feed (5.1 kg/t

of product) grid-powered, at the Vietnamese 2023 grid coefficient of 0.6592 tCO2/MWh, and 4.5 kg CO2-eq/t of feed (5.0 kg/t of product) diesel-generator powered.

Simulated concrete performance. The simulated 28-day performance of a reference C30/37 concrete (target mean strength 38.0 MPa, slump 120 mm, fresh density 2,400 kg/m³) is estimated from published strength reductions. Chloride penetration is estimated at 14 mm or less up to 50% replacement and above 15 mm beyond 65%, so the simulated concrete is durability-limited to 50% replacement for moderate exposure. The fine rows are flagged extrapolations: no source tests fine replacement.

Mix (simulated, 28 days)	Coarse / fine replacement (%)	Strength, mean (MPa)	Slump (mm)
Reference C30/37	**0 / 0**	**38.0**	**120**
Coarse 20%	20 / 0	36.0	110
Coarse 50%	50 / 0	31.9	95
Coarse 100%	100 / 0	27.0	85
Fine 20%	0 / 20	36.0	105
Fine 100%	0 / 100	25.1	60

Simulated control-loop response. The control loop was tested by scenario, not by measurement, with three feedstock cases — concrete-rich (75/10/10/5), base (55/30/10/5) and brick-rich (40/40/15/5). The controller sets rotor tip speeds of 68, 60 and 52 m/s, feed rates of 13.5, 12.5 and 11.0 t/h, and wash water at base, base and +15%, giving simulated product shares (sand / 5–10 mm / 10–20 mm / filler, %) of 15.0/28.0/52.0/5.0, 18.0/26.4/49.1/6.4 and 24.0/25.0/44.0/7.0. Nominal set points (design assumptions): particle-size sampling every 30 s, turbidity alarm at 200 NTU, feed-rate range 10–15 t/h, rotor-speed range 50–70 m/s, and a first-order loop response with a time constant of about 90 s. In the concrete-rich and base cases the loop holds the 10–20 mm share within 3 percentage points of its 50% of mineral feed target; in the brick-rich case it falls to 44%, because brick crushes finer and no adjustment can recover coarse stone the feedstock does not contain — the loop is a partial correction, not a complete one.

4. What it means — and what it does not

Three things have to be kept separate: the design itself — a complete line from receiving to washed, graded product, with closed oversize, water and sensor loops; the performance of that design in operation — grading, cleanliness, yield, energy and water use — which does not exist

yet as measurement, and is estimated by simulation in Section 3; and the performance of concrete made with the products, which exists only as the estimates in Section 3.

The design does have points worth discussing. The first is washing. Most demolition-waste lines stop at crushing, and their product carries cement dust, weak particles and light contaminants into concrete. Published work supports washing: a 2026 study found washing significantly improved mixed recycled coarse aggregate and gave concrete of comparable strength at replacement up to about 20% (Ferriz-Papi et al., 2026). The cost is water and sludge — which is why the recirculation tank and sludge press are part of the design, and why the water balance is the first thing a validation study must measure. The second point is the closed loops: oversize recirculation means the line does not generate a growing pile of material it cannot sell, and water recirculation means washing does not become a continuous discharge.

The third point is the sensor control. A fixed line set for one feedstock will drift when the feedstock changes, and demolition feedstock changes constantly. A controller that reads particle size and wash-water turbidity and adjusts feed, rotor speed and water flow is the right kind of answer, if the sensors are fast and reliable enough and the logic has been tuned on real feedstock. The dossier does not show that tuning. Until it does, the control system should be described as a design feature with a clear validation test — hold a grading band while the feed composition is deliberately varied — rather than as a proven capability.

The limits must be stated plainly. This paper describes a system as specified in a dossier, with its performance estimated by simulation, and it reports no measured data of any kind — its central limitation. No product sample has been tested, so grading, shape, density, absorption, fines, chloride, sulfate and contaminant content are simulated, not measured. No concrete has been made with those products, and no pilot run is reported, so the reference throughput of about 100 tonnes per day is a design figure and the yield is a simulated mass balance. No measured energy or water balance is given, and no life-cycle assessment, transport saving or landfill diversion figure exists for this line. The standards to be tested against are named — EN 12620:2013 and TCVN 7570:2006, with the RILEM types as the feedstock classification — but no test has been run, so the phrase "meets the standard" has no content in this paper. No feedstock variability study is reported, and the sensor control loop is a design description with a simulated response, not a demonstrated capability. The environmental case argues for building and testing the line; it is not evidence from a line already built.

The next step is a validation study: build or commission the line, run it on defined feedstocks, and measure each product band's grading and cleanliness, yield and throughput, energy and water use per tonne, and strength and durability of concrete made with the products against EN 12620 and TCVN 7570, with feedstock classified by the RILEM types. Until those measurements exist, the system should be presented as specified here — a plausible design whose performance is still to be shown by measurement.

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Data availability

No pilot data exist for this system. The source dossier and the copyright registration are held by the author. Measured product data, pilot records, and the energy and water balance do not exist yet; simulated estimates are in Section 3, and the validation study will supply the measurements.

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