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CIRCULAR CONSTRUCTION AT AIRPORTS

Delivering circular construction in airport infrastructure

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Date
May 2026

Commissioned by
European Union Horizon 2020 Programme - Grant Agreement No. 101036996

Developed as part of the TULIPS (demonsTrating lower pollUting soLutions for sustaInable airPorts) Work Package 6 — Circular Airports, Deliverable 6.5

About TULIPS
This publication was developed within TULIPS (demonsTrating lower pollUting soLutions for sustaInable airPorts acrosS Europe), a European innovation programme led by Schiphol and funded through the European Union's Horizon 2020 programme (Grant Agreement No. 101036996). TULIPS brings together a broad consortium of partners and accelerates the implementation of innovative and more sustainable airport solutions through demonstrations in live airport environments. Schiphol serves as the lighthouse testing ground for multiple demonstrations, enabling practical learning that can be scaled and replicated. The circular construction work within TULIPS directly shaped this booklet—translating evidence and on-the-ground experience into clear, actionable principles that airport teams can apply across the full asset lifecycle.

Co funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

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FOREWORD

Denise Pronk

HEAD OF SUSTAINABILITY
ROYAL SCHIPHOL GROUP

Airports are, by nature, long lived and highly regulated pieces of infrastructure. They must renew and expand while dealing with tight intervention windows, stringent certification requirements, and the realities of procurement, liability, and supply chain readiness. Decisions made in design and construction lock in material use, embodied carbon, and operational constraints for decades.

In practice, this means circularity is rarely held back by a lack of good ideas; it is held back by fragmentation, uncertainty, and a lack of sector specific guidance. That is why this booklet matters: it translates circular construction ambition into practical guidance that can be applied within real airport project environments—where safety, continuity of operations, and compliance are non negotiable.

"This booklet translates circular construction into practical action, supporting Schiphol's ambition to reduce CO_2 through better materials and design."

What makes this booklet particularly valuable is the depth of work behind it: it synthesises extensive research (hundreds of sources and thousands of best practices) and has been tested and refined through validation workshops with practitioners at Amsterdam Airport Schiphol and Avinor Oslo Airport.

We are grateful to the experts and practitioners who shared their time, experience, and honest feedback. We are proud of the role Schiphol Group has played in advancing circular construction in our sector, while recognising that the transition is still very much a work in progress. Circularity is a learning journey - one that asks for collaboration, transparency, and the willingness to improve with every project.

With this publication, we warmly invite airport owners, designers, builders, and suppliers to build on these principles and add their own insights. By continuing to lead - and by sharing what works, and what does not - Schiphol Group hopes to help grow a movement toward more circular, resilient, future-proof airports worldwide.

FOREWORD

Tor Ivar Hansen

HEAD OF CLIMATE AND ENVIRONMENT FOR CONSTRUCTION AND INFRASTRUCTURE
AVINOR OSLO AIRPORT

Circular construction is not only about reducing environmental impact, but about managing resources responsibly. At Avinor, sustainability is integral to how we develop and operate our airports. We are committed to reducing emissions, improving resource efficiency, and building infrastructure that responds to both current and future needs.

This commitment is reshaping how we approach construction. Across our projects—from terminal refurbishments to airside upgrades—we are testing new ways of working: reusing materials, designing for flexibility, and extending the lifespan of existing assets. In doing so, we are engaging with approaches that are still evolving within the sector.

"Circular construction is not only about reducing environmental impact, but about managing resources responsibly—helping Avinor reduce emissions, optimise asset use, and deliver long-term value across its airport portfolio."

Applying circular principles in an airport environment is not straightforward. Our infrastructure is complex, highly regulated, and operates continuously. Standard solutions rarely apply. What is needed are approaches that work within these constraints while still enabling progress.

The guidance developed through TULIPS provides this direction. It translates circular construction principles into practical frameworks that support decision-making in real airport contexts, helping to move from isolated pilot projects toward a more consistent and scalable approach.

For Avinor, circular construction is not only about environmental responsibility, but about managing resources intelligently and safeguarding long-term asset value. This publication represents an important step in that transition—and a foundation we will continue to build on.


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HOW TO USE THIS GUIDE?

Airports are long-lived, highly regulated, and almost continuously under construction. Decisions made early lock in material use, embodied carbon, and future adaptability for decades. This guide helps airport teams turn circular construction ambition into practical project decisions—while meeting safety, operational, and compliance requirements.

WHO IT IS FOR

· Procurement and contract managers (tendering, supplier requirements)
· Asset management and operations (maintenance, transformation planning)
· Contractors and suppliers (site practices, logistics, take-back, reuse)
· Sustainability practitioners (programme, policy, reporting)
· Project managers and client representatives (briefing, governance, delivery)
· Designers and engineers (concept, technical design, specifications)

WHEN TO USE IT

The framework is built around 5 connected pillars covering the full lifecycle. You can use them as a checklist at key decision moments during:

1. Circular Design
2. Circular Construction
3. Smart use & Transformation
4. High-value Deconstruction
5. System & Governance

Teams can use the pillars as a practical reference during design, procurement, construction, and transformation phases to support better circular decisions — helping define actions, set KPIs, avoid common pitfalls, and select appropriate tools and deliverables.

QUICK START (IF YOU HAVE LIMITED TIME)

1. Go to “At a glance: the 5 principles” and pick one pillar to improve in your next project.
2. Use the “Do this first” actions to start immediately.
3. Add 2–4 KPIs to your project dashboard (e.g., tonnes reused, % reused, CO_2e avoided, cost avoided).

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EXECUTIVE SUMMARY

Airports are complex, material-intensive environments operating continuously under strict safety, security, and certification requirements. At the same time, they are almost always building, renovating, or replacing assets. Decisions made early therefore lock in material use, embodied carbon, cost, and flexibility for decades. Circular construction shifts the model from build–use–demolish–replace to managing materials and components as long-term assets that retain value across multiple lifecycles. The challenge is not ambition, but implementation within airport reality—tight intervention windows, compliance requirements, and fragmented project delivery.

WHAT THIS GUIDE DOES

- Summarizes extensive research across 350 documents and best practices.
- Provides 5 connected pillars across the full lifecycle to embed circularity in construction.
- Translates circular construction principles into practical, airport-specific actions (what to do, when, and by whom).
- Offers actions, deliverables, KPIs, and tools to move from pilots to standard practice.

THE FIVE PILLARS

1. **Circular Design** – Make "build less, build smarter" the default—locking in material efficiency, flexibility, and reuse from the start.
2. **Circular Construction** –Turn circular design into real outcomes on site—through procurement, logistics, and execution.
3. **Smart use & Transformation** – Keep assets and materials in use longer—by embedding circularity in operations, contracts, and asset decisions.
4. **High-value Deconstruction** – Turn end-of-life into value recovery—by planning dismantling and securing reuse before it starts.
5. **System & Governance** – Make circular construction work at scale—by fixing governance, finance, risk, and system barriers.

This guidance has been co-created, tested, and validated with airport stakeholders across Europe. It reflects real project experience and is designed to work within operational constraints. The next step is full scale implementation—embedding these principles into everyday decisions and scaling them across the airport ecosystem.

AT A GLANCE: THE 5 PRINCIPLES

5 CONSTRUCTION PRINCIPLES
CIRCULAR DESIGN
Design for flexibility, modularity, and disassembly
Align all stakeholders early; assign ownership and set clear circular targets
Specify reused, recycled, biobased, and certified materials with clear requirements
Minimise material use and avoid mixed/toxic materials
Use digital tools (material passports) to track materials and performance
Challenge the need to build; maximise existing asset use first
CIRCULAR CONSTRUCTION
Track materials, waste, and emissions
Build with modular and or demountable systems
Coordinate logistics and material flows
Reuse first: use what already exists
Embed circularity in procurement and contracts
Ensure lean, low-waste site practices
SMART USE & TRANSFORMATION
Extend asset life through maintenance and monitoring
Use contracts and incentives to enable circular use
Enable reverse logistics and supplier take-back
Prioritise refurbishment and reuse before new build
Embed circularity in asset operations and transformation
HIGH VALUE DECONSTRUCTION
Conduct material audits and link them to reuse delivery
Enable selective dismantling where feasible
Plan dismantling early and make time for it
Use hubs and storage where they add value
Coordinate reuse flows across projects
SYSTEMS & GOVERNANCE
Embed circularity in core business and governance
Use metrics to steer decisions—not just report
Align circularity with climate, resilience, and ESG goals
Align financial models with lifecycle and material value
Validate performance and share learning across projects
Enable reuse by adapting risk, compliance, and supply chains

WHY AIRPORTS MATTER FOR THE CIRCULAR ECONOMY

Airports as system actors, not just projects

By 2050, Europe aims to operate within a fully circular economy—one in which materials retain value, waste is designed out, and construction becomes a continuous cycle. Policies such as the EU Circular Economy Action Plan, Ecodesign for Sustainable Products Regulation, and CSRD (E5) are accelerating this shift by placing new expectations on material efficiency, lifecycle performance, and transparency.

In this transition, airports occupy a unique and influential position. They are not only infrastructure assets; they are long-lived systems that combine large material flows, continuous development, and long-term ownership within a highly regulated environment. Decisions made at airports do not just affect single projects—they shape material use, emissions, and adaptability for decades.

Why airports are a leverage point

Airports matter for circular construction for four structural reasons:

- Scale and continuity: Airports are among the most material-intensive environments in the built sector and are almost continuously under construction—through expansions, refurbishments, renewals, and fit-outs. This creates a steady pipeline of projects where circular principles can move from pilots to standard practice.
- Long-term asset ownership: Unlike many commercial developments, airports typically retain ownership of assets over long time horizons.

This makes lifecycle value, reuse potential, and future adaptability directly relevant to decision-making.

- Existing systems and governance: Airports already operate sophisticated systems for asset management, compliance, certification, and safety. These structures provide a strong foundation for material tracking, data governance, and lifecycle-based decisions—if circularity is integrated into them.
- Ability to orchestrate ecosystems: With multiple projects, suppliers, tenants, and contractors operating simultaneously, airports have the potential to act as orchestrators of circular material flows—connecting donor projects with future demand, rather than treating each project in isolation.

From infrastructure operators to material stewards

Taken together, these characteristics position airports as critical testbeds for making circular construction work in complex, real-world environments. If circularity can be implemented under the constraints of airport operations—where safety, certification, and continuity are non-negotiable—it can work anywhere.

However, potential alone is not enough. Despite strong policy signals and growing ambition, circular construction at airports remains fragmented. Understanding why implementation stalls in practice is the next step.

MAKING CIRCULAR CONSTRUCTION WORK IN AIRPORTS

From ambition to implementation

Circular construction is no longer a question of what to do. The principles are well established, widely researched, and broadly agreed upon. The real challenge—particularly in airport environments—is how to implement them consistently within day-to-day project realities. Today, circular outcomes at airports are most often achieved through individual champions, pilot projects, or isolated innovations. These efforts prove that circular construction is possible—but they rarely translate into standard practice.

The implementation gap

Across airports, several structural barriers prevent circular principles from scaling:

- Fragmented decision-making: Design, construction, operations, procurement, and asset management are often separated by organisational boundaries. Circularity falls between functions rather than being owned by one.
- Timing constraints: Circular decisions are frequently addressed too late—after design freezes, tender releases, or demolition planning—when reuse, flexibility, and disassembly options are already locked out.
- Governance and procurement misalignment: Circularity is not consistently embedded in briefs, contracts, or evaluation criteria. Financial models still prioritise upfront CAPEX over lifecycle value, while risk, insurance, and liability frameworks create default resistance to reuse.
- Limited material visibility: Materials are released and procured on a project-by-project basis, with little coordination across time or location. Reuse opportunities are missed simply because materials are not visible or available when needed.
- Data exists, but is not operationalised: Digital tools such as BIM, asset databases, passports, and LCAs exist in many airports, but are not consistently used to steer decisions during design, construction, and transformation.

What this means in practice

As a result, circular practices:

- remain concentrated in non-critical or non-passenger areas,
- depend heavily on individual motivation rather than system design,
- are vulnerable to time pressure and operational risk,
- and struggle to survive procurement, compliance, and delivery realities.

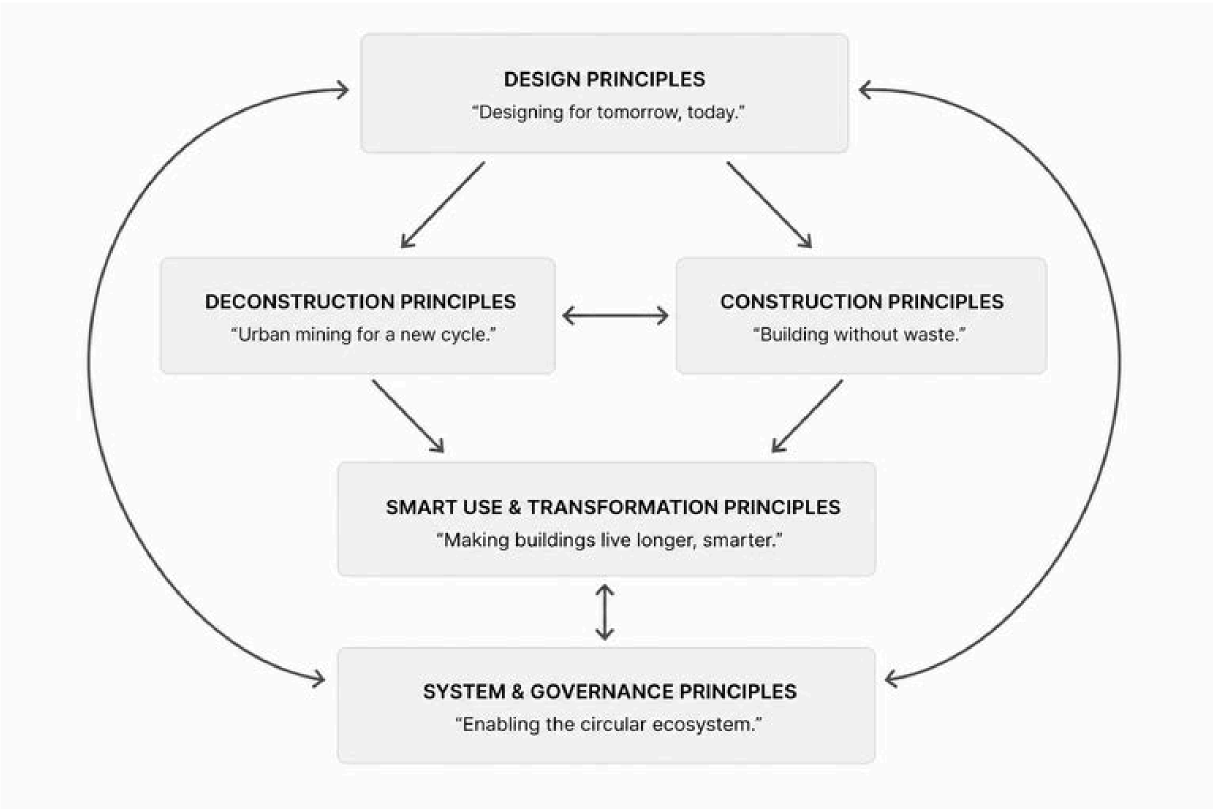
The issue is not capability—it is integration.

Why a structured, lifecycle-based approach is needed

To move from pilots to standard practice, circular construction must be:

- embedded across the full asset lifecycle,
- aligned with existing airport governance and delivery structures,
- and supported by clear roles, decision moments, and practical tools.

This framework responds directly to the implementation gap. It translates circular construction principles into airport-specific actions—clarifying what to do, when decisions matter most, and who needs to be involved at each stage. By connecting projects over time, aligning stakeholders, and embedding circularity into everyday decisions, airports can shift from isolated successes to consistent, scalable circular construction.



The five principles in this guide are intended as a shared framework, not a prescriptive checklist. Not every principle, action, or tool will be equally relevant for every airport, asset type, or project. Applicability depends on factors such as asset criticality, passenger exposure, regulatory requirements, available intervention time, and whether work concerns new build, refurbishment, fit-out, or end-of-life activities. The aim is not to apply everything at once, but to prioritise high-impact actions at the moments that matter most, and to build circularity progressively into standard practice over time.

HOW THE FRAMEWORK WAS DEVELOPED

The framework was developed through a structured, multi-step process combining extensive research, practical application, and validation with airport stakeholders. More than 350 sources and 4,000 best practices were analysed, consolidated, and translated into a lifecycle-based approach tailored to the operational and regulatory realities of airports.

DEFINE & STRUCTURE

- Identified airport-specific constraints
- Defined lifecycle across 5 stages

REVIEW & CONSOLIDATE

- Reviewed ~350 sources
- Consolidated 4,000+ practices

TEST & VALIDATE

- Conducted validation with airports*
- Iterated with stakeholder feedback

** Validation session with Royal Schiphol Group and key stakeholders on circular building and infrastructure construction (September 2025)*

The framework was shaped through multiple rounds of engagement with industry professionals, whose insights and feedback were essential to its development. Contributions were gathered through pre-review, interactive workshops, and both online and in-person sessions, including detailed discussions across each lifecycle stage. We would like to thank all contributors for their time, expertise, and commitment, which ensured the framework is both practical and grounded in real airport experience.

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THE FIVE PRINCIPLES IN PRACTICE


5 CONSTRUCTION PRINCIPLES
CIRCULAR DESIGN
Design for flexibility, modularity, and disassembly
Align all stakeholders early; assign ownership and set clear circular targets
Specify reused, recycled, biobased, and certified materials with clear requirements
Minimise material use and avoid mixed/toxic materials
Use digital tools (material passports) to track materials and performance
Challenge the need to build; maximise existing asset use first
CIRCULAR CONSTRUCTION
Track materials, waste, and emissions
Build with modular and or demountable systems
Coordinate logistics and material flows
Reuse first: use what already exists
Ensure lean, low-waste site practices
Embed circularity in procurement and contracts
SMART USE & TRANSFORMATION
Extend asset life through maintenance and monitoring
Use contracts and incentives to enable circular use
Enable reverse logistics and supplier take-back
Prioritise refurbishment and reuse before new build
Embed circularity in asset operations and transformation
HIGH VALUE DECONSTRUCTION
Conduct material audits and link them to reuse delivery
Enable selective dismantling where feasible
Plan dismantling early and make time for it
Use hubs and storage where they add value
Coordinate reuse flows across projects
SYSTEMS & GOVERNANCE
Embed circularity in core business and governance
Use metrics to steer decisions—not just report
Align circularity with climate, resilience, and ESG goals
Align financial models with lifecycle and material value
Validate performance and share learning across projects
Enable reuse by adapting risk, compliance, and supply chains

1. CIRCULAR DESIGN

One-line promise: Make “build less, build smarter” the default—locking in material efficiency, flexibility, and reuse from the start.

WHY THIS MATTERS IN AIRPORTS?

- The lifespan of building assets is often shorter than the materials
- Early design decisions lock in material use, carbon, and flexibility for decades
- Strict operational and certification constraints mean circularity must be designed in from the start
- Reuse and disassembly depend on early alignment on materials, data, and stakeholders

DO THIS FIRST

1. Run a "necessity + alternatives" check: maximise existing asset use before new build
2. Set clear circular targets and ownership in the project brief (reuse %, CO_2, material criteria, budget/business case)
3. Ensure feedback loops between operations, maintenance, and design

WHO NEEDS TO BE IN THE ROOM

- Accountable – Client Project Manager / Asset Owner
- Core team – Sustainability, Design Lead, (project) Engineering, Operations, Procurement, Reuse coordinator
- Consulted – HSE, Security, Maintenance, Key Suppliers, External partners (e.g. airlines, municipalities, advisors)
- Informed – Finance, Commercial / Tenants

WHEN DECISIONS MATTER MOST

- By end of Concept Design: Circular targets, reuse opportunities, and flexibility strategy defined and agreed
- Before Technical Design freeze: Design for Disassembly (DfD) and modularity, material criteria (incl. non-toxic), and data requirements confirmed

TYPICAL DELIVERABLES

- Circular requirements defined (targets + roles) in Sustainable Project Dossier
- Phase decisions documented for later stages
- Material selection criteria (reuse, recycled/biobased, exclusions)
- BIM model with data
- DfD requirements integrated into design, specifications, and dismantling instructions

1. CIRCULAR DESIGN PRINCIPLES

1. Challenge the need to build; maximise existing asset use first

- Challenge the need to build; identify underused spaces and increase usage intensity
- Apply tools such as Intensity of Use (IU) ratio and assess shared and multi-functional use
- Use pre-design assessments, harvest maps, and alternative scenarios
- Prioritise resource efficiency from the earliest project stages

2. Align all stakeholders early; assign ownership and set clear circular targets

- Involve internal and external stakeholders early and throughout design
- Establish feedback loops between operations, design, and supply chain
- Define clear roles, responsibilities, and ownership for circularity and structure this with a communication plan
- Set and monitor circular targets (e.g. reuse %, material criteria, CO_2)

3. Design for flexibility, modularity, and disassembly

- Design for adaptability, multifunctionality, and selective disassembly
- Apply standardised design and DfD principles (e.g. ISO 20887)
- Focus modularity on shearing layers and components that change over time
- Assess materials and products on reusability, dismantlability, and recyclability

4. Minimise material use and avoid mixed/toxic materials

- Reduce material demand through efficient design and prefabrication
- Avoid mixed materials that limit reuse potential
- Use as much biobased materials as possible
- Exclude toxic materials that hinder recovery and reuse
- Enable material sorting, storage, and reuse flows

5. Specify reused, recycled, biobased, and certified materials with clear requirements

- Prioritise secondary, biobased, and non-toxic materials
- Translate ambitions into clear specifications (e.g. recycled content targets)
- Apply certified materials and integrate take-back guarantees
- Link material choices to CO_2, resource use, and project KPIs

6. Use digital tools to track materials and performance

- Use BIM, material passports, and LCA as active decision-making tools
- Ensure data is reliable, interoperable, and continuously updated
- Track material flows, reuse rates, and environmental performance
- Use data outputs to inform design, procurement, and lifecycle decisions

1. CIRCULAR DESIGN

WATCH OUT
(Common pitfalls in airport projects)

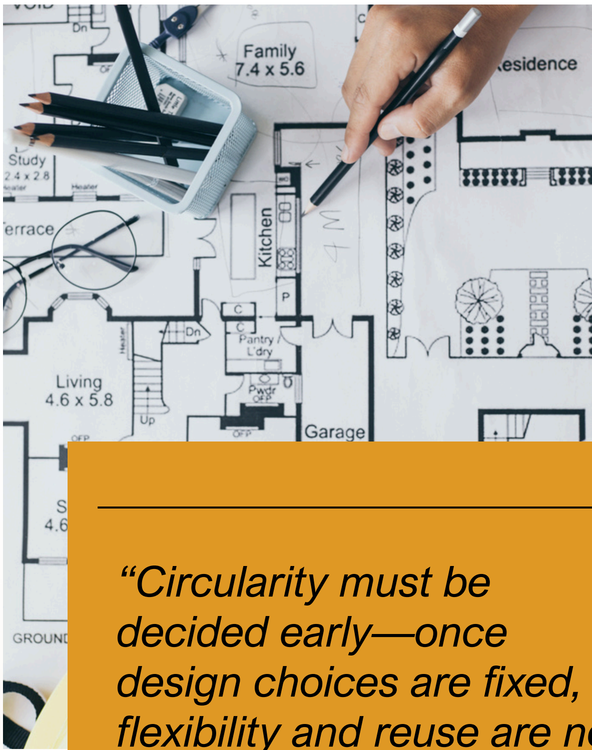
- Contractual requirements that mandate “new” materials and limit reuse (minimal buffers and flexibility: Focus on optimization based on PAX)
- Circularity addressed too late (after tender), limiting impact on materials and systems
- Acronyms and (digital) tools not shared or used across teams - creates gaps in implementation

KPI CHECK (Pick 2–4)

- % of floor area / scope delivered via reuse/refurbishment instead of new build
- % reused / secondary / biobased materials specified (by mass or by key categories)
- Embodied CO_2e target vs baseline (tracked from design stage)
- % of key components with complete material data at design freeze (“passport coverage”)
- % of components designed for disassembly or modularity
- Building Circularity Index (BCI)

TOOLS YOU COULD USE

- Necessity check / alternatives matrix (reuse-first decision tool) & communication plan
- 10R principles and Value Hill
- Internal marketplace to engage reuse supply chains early
- Circular brief checklist + target sheet
- DfD / modularity checklist & deconstruction plan
- BIM/material passport minimum data fields

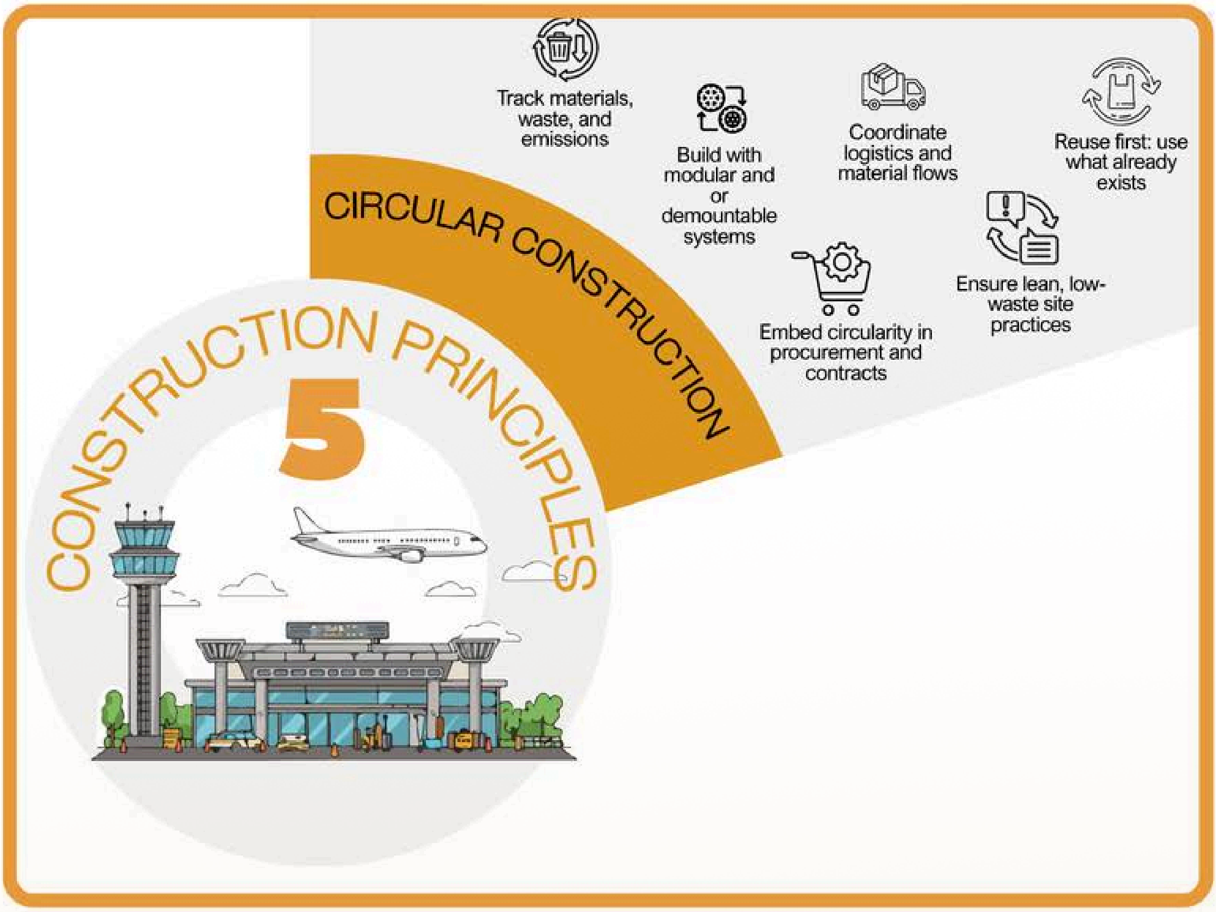


“Circularity must be decided early—once design choices are fixed, flexibility and reuse are no longer an option.”

- John Hijma (Benthem Crouwel NACO)

2. CIRCULAR CONSTRUCTION

One-line promise: Turn circular design into real outcomes on site—through procurement, logistics, and execution.



WHY THIS MATTERS IN AIRPORTS?

- Construction is time-critical and disruption-sensitive; circularity must work within tight operational windows
- Short lifecycles (e.g. commercial areas) create strong opportunities for reuse if storage and logistics are in place
- Lack of inventory visibility and fragmented information limits reuse in practice

DO THIS FIRST

1. Establish a clear inventory overview before project start
2. Align requirements across stakeholders and contracts early
3. Implement material, waste, and logistics CO_2 tracking from day one

WHO NEEDS TO BE IN THE ROOM

- Accountable – Client PM / Procurement lead
- Core team – Contractor PM, Sustainability, Logistics, Site manager
- Consulted – HSE / Security, Designers / Engineers, Suppliers
- Informed – Finance, Asset management

WHEN DECISIONS MATTER MOST

- Before tender release: circular criteria, targets, and data reporting requirements defined. In addition, ensure inventory availability and reuse potential confirmed
- At construction start: site rules, logistics setup, storage, logistics, and site rules operational

TYPICAL DELIVERABLES

- Tender circular requirements and evaluation criteria
- Inventory / material availability overview
- Logistics and storage plan for materials and reuse flows
- Site “Clean Site Charter” and circular site rules

2. CIRCULAR CONSTRUCTION PRINCIPLES

1. Reuse first: use what already exists

- Define quality standards for reused materials
- Check storage, inventories, and donor buildings before new procurement
- Integrate harvested materials from other projects
- Use digital tools to track material availability
- Align reuse responsibilities between client and contractor
- Maintain an overview of available materials and storage locations

2. Embed circularity in procurement and contracts

- Assign a reuse manager for implementation and reporting
- Integrate reuse and CO_2 targets into tenders and contracts
- Define measurable circular objectives
- Allocate budgets early for reused and low-carbon materials
- Define communication, reporting, and approval responsibilities
- Enable reuse in customer-facing areas

3. Build with modular and/or demountable systems

- Apply modular, prefabricated, and industrialised construction methods
- Enable selective dismantling and component reuse
- Design adaptable layers (fit-out, partitions, services, cladding)
- Plan upgrades and partial disassembly instead of full rebuilds
- Track prefabrication performance (cost, waste, time)

4. Ensure lean, low-waste site practices

- Prevent waste and separate material streams on-site
- Apply closed-loop systems for water, dust, and energy
- Implement and enforce clear site rules (e.g. Clean Site Charter)
- Standardise data collection on waste, logistics, and prefabrication

5. Coordinate logistics and material flows

- Use just-in-time delivery and shared logistics hubs
- Coordinate reuse flows across projects and supply chains
- Enable temporary storage and material hubs for reuse
- Track logistics-related CO_2 as part of project carbon budgets
- Enable storage to support reuse of short-lifecycle assets (e.g. commercial fit-outs)

6. Track materials, waste, and emissions

- Track material flows, waste fractions, and reuse rates
- Monitor CO_2 emissions across construction and logistics
- Ensure data consistency across project phases
- Use simple and consistent data to verify performance and inform future projects, e.g. BIM Model

2. CIRCULAR CONSTRUCTION

WATCH OUT
(Common pitfalls in airport projects)

- Lack of storage and logistics planning leads to "material graveyards"
- Inconsistent definitions between client and contractor (e.g. what counts as reuse)
- Customer-facing requirements enforce "as-new" materials unnecessarily
- Reusable materials aren't good enough after all

KPI CHECK (Pick 2–4)

- Tonnes of materials reused (and % of total material mass)
- CO_2e and costs avoided through reuse and low-carbon materials (construction stage)
- Waste diversion rate (by fraction) and contamination rate on-site
- % of projects with inventory checked before procurement
- % reuse delivered vs planned (captures drop-off)
- Building/Material Circularity Index

TOOLS YOU COULD USE

- Circular procurement clauses (reuse targets, take-back, data reporting)
- Inventory / material registry and or marketplace tools
- Reuse tracking vs planned (monitor delivery gap)
- Clean Site Charter (poster + site checklist)
- Material, waste, and logistics tracking tools

"Circular construction is not about ambition—it's about whether procurement, logistics, and site practices actually deliver what was designed."

- Guillaume Rose (Elioth by Egis)

3. SMART USE AND TRANSFORMATION

One-line promise: Keep assets and materials in use longer—by embedding circularity in operations, contracts, and asset decisions.

WHY THIS MATTERS IN AIRPORTS?

- Replacement is often the default—even when refurbishment is possible
- Circularity is hard to enforce: assets are controlled by different actors (operations, tenants, suppliers)
- Many tools and initiatives exist, but are not consistently used or embedded in daily work

DO THIS FIRST

1. Apply a "preserve/refurbish/reuse first" rule in asset and maintenance decisions (not only in projects)
2. Embed circular KPIs + follow-up responsibility in contracts and leases (especially for tenants)
3. Start with simple, usable data (logbooks, existing systems)—focus on use, not new tools

WHO NEEDS TO BE IN THE ROOM

- Accountable: Asset management lead
- Core team: Main contractors, Operations & Maintenance, Commercial / leases, Sustainability
- Consulted: Procurement, Key suppliers, IT / data
- Informed: Finance, Project teams

WHEN DECISIONS MATTER MOST

- Asset planning: challenge replacement vs refurbishment (default shift)
- Contract / lease renewal: define AND assign responsibility for circular KPIs
- Maintenance planning: decide whether to extend, refurbish, or replace

TYPICAL DELIVERABLES

- Maintenance strategy based on actual asset condition and use
- Contracts and leases with clear KPIs + assigned follow-up responsibility
- Reverse logistics / take-back agreements with suppliers

3. SMART USE AND TRANSFORMATION PRINCIPLES

1. Extend asset life through maintenance and monitoring

- Apply predictive maintenance where feasible, building on existing tools (e.g. building analyses tools)
- Use KPIs (service life, renovation rate) to guide maintenance and replacement decisions
- Ensure data is integrated and usable across departments
- Expand monitoring beyond critical assets where practical

2. Use contracts and incentives to enable circular use

- Integrate circular KPIs (CO_2, energy, waste) into contracts and leases
- Apply financial incentives (e.g. waste pricing) to drive behaviour
- Enable repair, refurbishment, and reuse through contractual requirements
- Ensure consistent follow-up and enforcement, especially for tenant-controlled assets

3. Enable reverse logistics and supplier take-back

- Require suppliers to take back, refurbish, or recycle components
- Establish practical reverse logistics systems for material return flows
- Coordinate reuse through contracts and structured agreements
- Build scale through collaboration and joint procurement

4. Prioritise refurbishment and reuse before new build

- Apply a "reuse first" approach before replacing assets
- Upgrade and repurpose assets where technically and operationally viable
- Use KPIs (e.g. % refurbished) to guide decisions
- Balance lifespan extension with performance, cost, and safety

5. Embed circularity in asset operations and transformation

- Prioritise refurbishment and adaptive reuse in strategic asset decisions
- Use building data and material inventories to support transformation planning
- Integrate circular KPIs into renovation and operational decision-making
- Assign clear ownership for reuse, maintenance, and transformation outcomes
- Align stakeholders around long-term building adaptability and reuse value

3. SMART USE AND TRANSFORMATION

WATCH OUT
(Common pitfalls in airport projects)

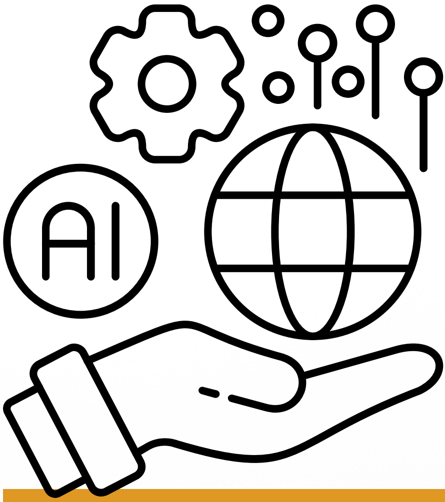
- Circularity is included in contracts but not followed up or enforced and too much focus on recycling (which often results in downcycling)
- Circularity is seen as “not my responsibility” across teams and tenants
- Tools and data exist but are not used, shared, or understood
- Assets are extended too long without planned refurbishment, creating future backlog

KPI CHECK (Pick 2–4)

- Refurbishment vs replacement rate (are we really building less?)
- Asset life extension achieved (years, key systems)
- % contracts with circular KPIs and active follow-up
- Assets/components returned via take-back or reuse routes

TOOLS YOU COULD USE

- Refurbishment-first decision framework (used in asset planning)
- Circular lease clauses with enforcement and follow-up
- Reverse logistics / supplier take-back agreements
- Simple dashboards such as PowerBI using existing data (logbooks, BIM where useful)



“Circular use doesn’t fail on ideas—it fails on ownership, follow-up, and making it part of daily operations.”

- Tim Muller
(Royal Heijmans)

4. HIGH-VALUE DECONSTRUCTION

One-line promise: Turn end-of-life into value recovery—by planning dismantling and securing reuse before it starts.

WHY THIS MATTERS IN AIRPORTS?

- Time pressure and operations often lead to fast demolition—reuse is lost if not planned early
- Materials are mapped but not reused—decisions depend on cost, logistics, and ownership
- Airports can enable reuse across projects—but only if storage, timing, and demand are aligned

DO THIS FIRST

1. Start end-of-life planning early in the project lifecycle and allocate time explicitly for dismantling
2. Identify what is worth saving: Perform a pre-demolition audit and link it to a reuse decision and business case
3. Secure reuse routes (internal, external, donation) before dismantling starts

WHO NEEDS TO BE IN THE ROOM

- Accountable: Client PM / Asset owner
- Core team: Deconstruction contractor, Sustainability, Logistics, Safety / HSE
- Consulted: Designers (for reintegration), Procurement, Insurers / quality
- Informed: Operations, Finance

WHEN DECISIONS MATTER MOST

- When demolition is proposed: require audit + reuse option + business case (not just approval)
- Before site works: confirm dismantling method, storage/logistics, and actual reuse destination

TYPICAL DELIVERABLES

- Pre-demolition audit linked to reuse plan and business case
- Selective dismantling plan (“reverse IKEA manual”)
- Storage / hub plan + reverse logistics plan
- Reuse pathway (internal reuse, resale, or donation)

4. HIGH-VALUE DECONSTRUCTION PRINCIPLES

1. Plan dismantling early and make time for it

- Start planning dismantling early and allocate time explicitly in project schedules
- Enable selective dismantling within operational constraints
- Use clear dismantling instructions ("reverse IKEA manual")
- Coordinate early to connect materials with reuse opportunities

2. Conduct material audits and link them to reuse delivery

- Carry out pre-demolition audits (quantities, condition, reuse potential)
- Link audits to concrete reuse plans, budgets, and timelines
- Ensure audits lead to reuse decisions and business cases
- Enable teams to understand materials through site walks

3. Enable selective dismantling where feasible

- Apply structured dismantling processes where feasible
- Integrate dismantling into project delivery and planning
- Balance safety, certification, operational constraints, and cost
- Use dismantling as an alternative to demolition when viable

4. Use hubs and storage where they add value

- Develop storage, hubs, and marketplaces where feasible
- Enable temporary storage and re-certification of components
- Balance storage costs with reuse value; avoid unused stock
- Use airports as material banks where space and demand allow

5. Coordinate reuse flows across projects

- Establish reverse logistics between projects and stakeholders
- Prioritise high-value reuse and remanufacturing
- Engage suppliers through take-back systems
- Enable reuse across projects by overcoming silos and aligning incentives

4. HIGH-VALUE DECONSTRUCTION

WATCH OUT
(Common pitfalls in airport projects)

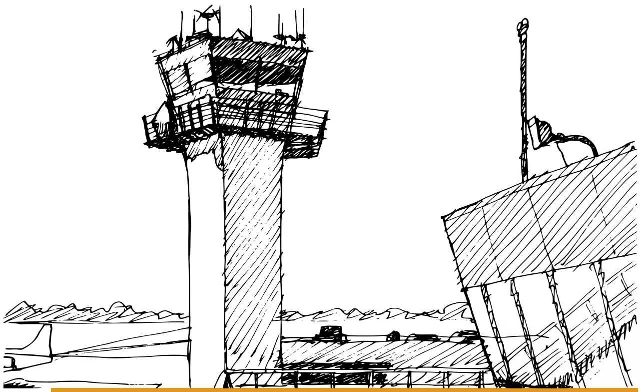
- Time is known early—but not allocated, leading to fast demolition
- Storage is expensive—without clear reuse routes, materials lose value
- Projects work in silos—reuse across projects does not happen
- Safety and certification override reuse when not addressed early

KPI CHECK (Pick 2–4)

- Tonnes recovered for reuse (vs recycled vs disposed)
- % materials with confirmed reuse route before dismantling
- Reuse delivered vs planned (captures drop-off)
- CO_2e and cost avoided through recovered materials

TOOLS YOU COULD USE

- Pre-demolition audit (linked to reuse decisions)
- Selective dismantling plan + labelling protocol
- Material value scan / Residual Value Assessment
- Reuse route checklist (internal / external / donation)
- Storage / hub decision tool (cost vs value vs demand)



"Dismantling creates value only when reuse is planned, funded, and connected to demand."

- Rune Bjørnstad (Avinor Oslo Airport)

5. SYSTEM & GOVERNANCE

One-line promise: Make circular construction work at scale—by fixing governance, finance, risk, and system barriers.

WHY THIS MATTERS IN AIRPORTS?

- Circularity is inconsistently applied—embedded in some projects but not standard practice
- Fragmentation across governance, standards, and tools prevents scaling
- Finance, risk, and accounting systems often block reuse and lifecycle decisions

DO THIS FIRST

1. Embed circular requirements into governance and procurement as standard so it becomes clear who decides on reuse
2. Define a small, standard KPI set and use it in real decisions—not just reporting
3. Align finance, risk, and legal early to remove barriers to reuse (CAPEX/OPEX, warranties, accounting)

WHO NEEDS TO BE IN THE ROOM

- Accountable: Executive sponsor / Programme owner
- Core team: Sustainability, Procurement, Governance, Asset management
- Consulted: Finance, Risk/insurance, Legal, Data/IT
- Informed: Contractors/suppliers, Operations

WHEN DECISIONS MATTER MOST

- Portfolio planning: define targets, ownership, and standard approach (not project-by-project)
- Procurement setup: apply circular criteria consistently across contracts
- Post-project review: compare planned vs actual and update standards and understand what has priority if goals conflict

TYPICAL DELIVERABLES

- Circular construction policy + standard procurement approach
- Risk/insurance acceptance framework for reused materials
- Post-project evaluation template (incl. lifecycle + reuse outcomes)

5. SYSTEM & GOVERNANCE PRINCIPLES

1. Embed circularity in core business and governance

- Integrate circularity across policies, permits, and procurement
- Ensure clear ownership and leadership accountability (avoid fragmentation)
- Set reuse targets in projects and contracts
- Move from pilots to standard practice embedded in core processes

2. Use metrics to steer decisions—not just report

- Define standard indicators (reuse, CO_2, cost, lifecycle)
- Align fragmented standards into a clear, airport-specific framework
- Move from compliance reporting to active decision-making
- Ensure tools and dashboards are known, accessible, and used across teams

3. Align financial models with lifecycle and material value

- Integrate lifecycle performance and material value into decisions (TCO)
- Address CAPEX/OPEX barriers that block circular solutions
- Develop business cases that show long-term value
- Adapt accounting rules to enable reuse (avoid treating reused assets as new capital)
- Use incentives and funding to scale circular solutions

4. Enable reuse by adapting risk, compliance, and supply chains

- Involve risk, legal, and control functions early
- Adapt insurance and contracts to enable reuse
- Ensure quality and liability through structured supply chains
- Clarify acceptance criteria so reused materials are not rejected by default

5. Align circularity with climate, resilience, and ESG goals

- Integrate circularity into climate, resilience, and social strategies
- Align with frameworks (EU Taxonomy, CSRD, etc.)
- Position circularity as part of ESG performance
- Embed these goals into investment and project decisions

6. Validate performance and share learning across projects

- Apply lifecycle metrics (CO_2, TCO, reuse potential) across projects
- Include end-of-life impacts and post-project evaluation
- Compare planned vs actual performance
- Enable learning across projects (break silos and share outcomes)

5. SYSTEM & GOVERNANCE

WATCH OUT
(Common pitfalls in airport projects)

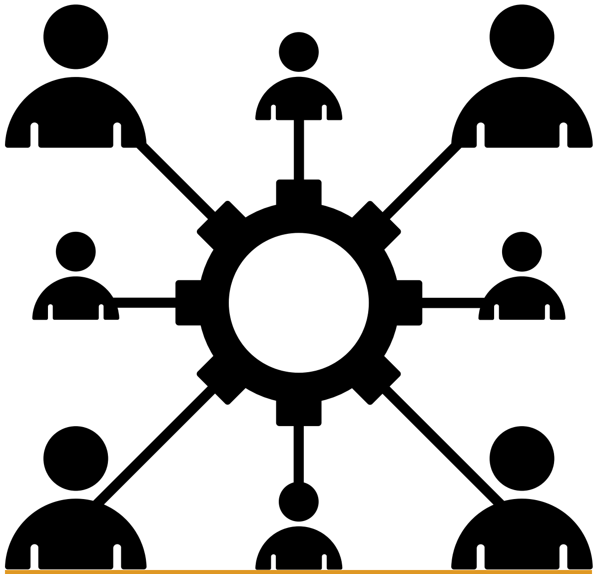
- Circularity remains in pilot mode and is not embedded in core processes
- Metrics and tools exist but are not used or understood across teams
- CAPEX/OPEX and accounting rules block circular decisions
- No clear ownership—circularity becomes “everyone and no one’s responsibility”

KPI CHECK (Pick 2–4)

- Portfolio-wide reuse % (standard definition across projects)
- Portfolio-wide CO_2e (used for comparison and target-setting)
- TCO comparison (circular vs baseline)
- % projects with verified post-project evaluation (learning loop closed)

TOOLS YOU COULD USE

- Standard KPI definitions + dashboard used across teams
- Circular procurement clauses + evaluation criteria
- Reuse acceptance framework (quality, warranty, liability)
- Post-project evaluation tool (linked to standards update)



“Circularity only scales when it becomes part of how decisions are made—not an add-on”

- Susanne IJsenbrandt (Royal BAM Group)

CASE EXAMPLES

The principles in this framework are already being applied in airport projects today. The following cases show how circular construction works in practice—within the constraints of safety, operations, and cost. They highlight not only what is possible, but also where trade-offs, limitations, and real decisions shape the outcome.

CASE: CIRCULAR SECURITY CHECKPOINT (DLP90), SCHIPHOL AMSTERDAM

Ronald Lunstroo

At Schiphol, circular construction is moving beyond ambition into practice. The construction of security checkpoint DLP90 shows how circular principles can be applied within a highly operational and regulated airport environment.

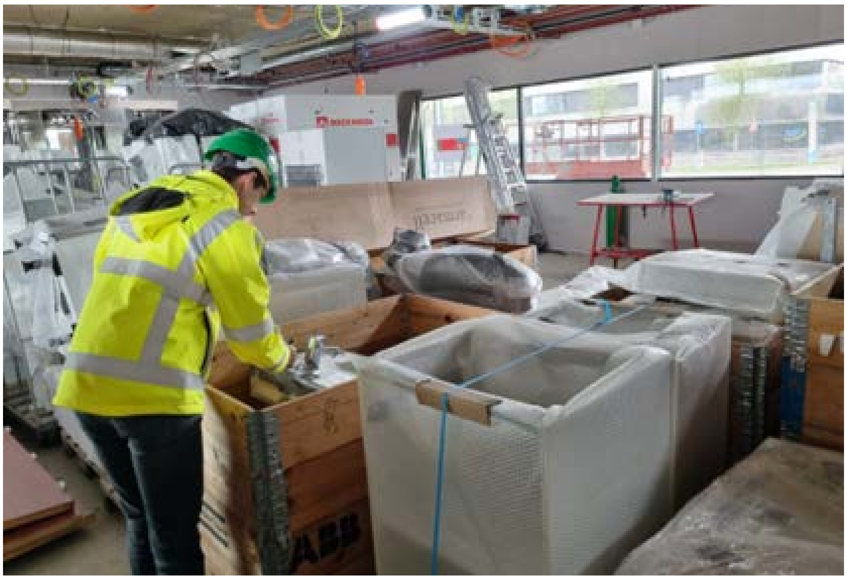
Instead of following a traditional demolition-and-build approach, the project started from what was already available. Materials from a nearby building scheduled for demolition were carefully dismantled, catalogued, and reused. Steel structures and interior elements such as doors, ceiling seals and lighting were not treated as waste, but as assets for the new building.

This required a different way of working. Demolition, design and construction were closely integrated, with reuse opportunities informing design decisions from the start. Rather than designing first and sourcing materials later, the process was partially reversed: available materials helped shape the final design. This approach—often referred to as “reverse construction”—allowed for a high level of reuse while maintaining the required safety, quality, and performance standards.

The project demonstrates that circular design and construction is possible within the constraints of an airport, but also highlights what it takes to make it work: early planning, collaboration across the supply chain, and flexibility in both design, project requirements and procurement.

DLP90 is not just a circular building. It is a practical example of how material reuse, design for disassembly, and lifecycle thinking can be integrated into real airport projects—without compromising on operations.

Building Circularity Index: 68%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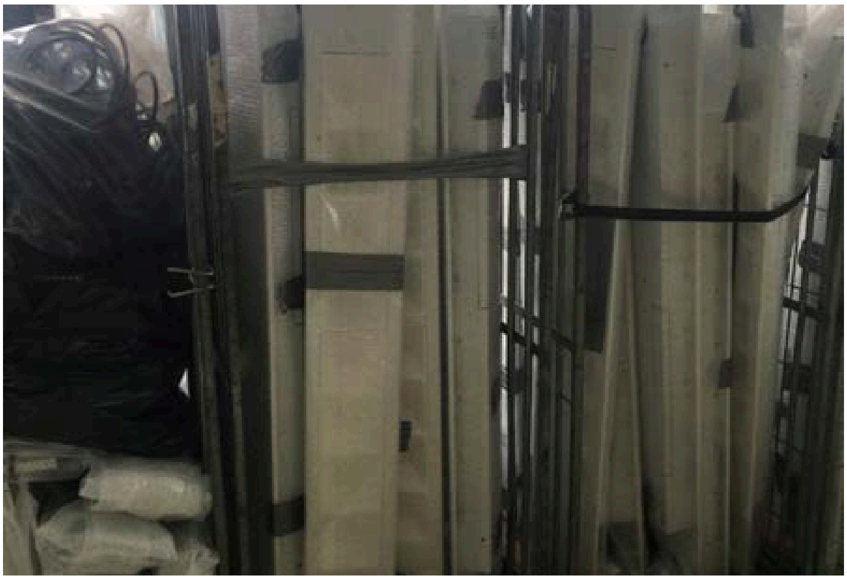


CASE: CIRCULAR SECURITY CHECKPOINT (DLP90), SCHIPHOL AMSTERDAM

How this case links to the framework

This project demonstrates how circular outcomes depend on early decisions and cross-pillar alignment. Reuse was enabled because materials were identified, dismantled, and matched to demand before design and construction were fixed.

Key principles illustrated:

- Circular Design: Designing with available materials, not just for new procurement ("reverse construction")
- Circular Construction: Integrating inventory, procurement, and site execution to deliver planned reuse
- High-Value Deconstruction: Selective dismantling of a donor building to retain material value

What to take into your next project:

Circular construction is achievable in safety-critical, operational environments—if reuse is planned early, responsibilities are clear, and design, deconstruction, and construction are treated as one integrated process.

CASE: REUSE OF GATE FOP49, AVINOR OSLO AIRPORT

Tor Ivar Hansen

At Oslo Airport, circular construction is applied through the deconstruction and rebuilding of an airport gate, demonstrating how reuse can be integrated into complex, operational infrastructure.

Rather than approaching the project as a conventional renovation, the process started with understanding what was already there. Existing materials and components were carefully assessed through on-site inspections, supported by digital models and 3D scans. Structural elements such as steel framing, façade sections, and large interior assemblies were evaluated for their potential to be reused.

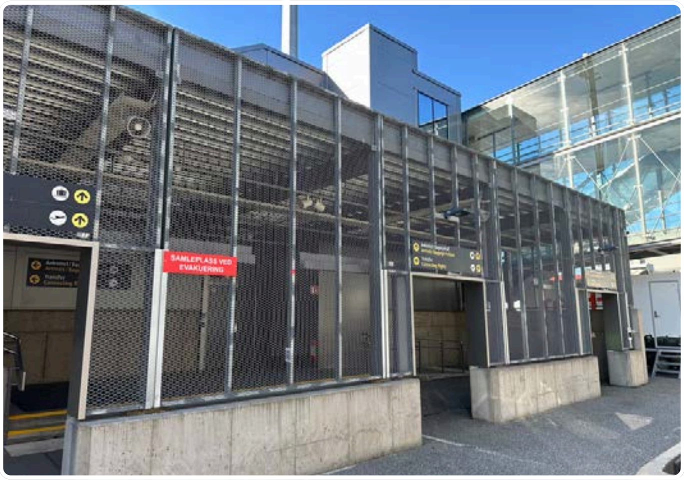
This required a different way of working. Material inventories and resource passports were developed before deconstruction began, capturing key information on condition, dimensions, and performance. Components suitable for reuse were documented, labelled, and tracked, allowing them to be reintroduced into the project in a controlled and traceable way.

Design and engineering were closely aligned with this process. Instead of defining solutions upfront, decisions were informed by the availability and quality of existing materials. This created a more adaptive approach, where reuse potential influenced both technical and spatial outcomes.

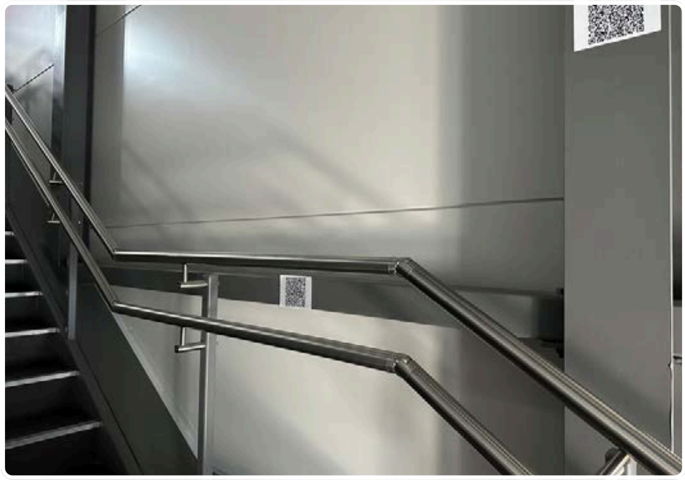
The project shows that circular construction in airports is not limited to new build, but can be effectively applied to existing assets. At the same time, it highlights the importance of early-stage data collection, coordination across teams, and the integration of digital tools to support decision-making.

The Gate FOP49 pilot demonstrates how material inventories, resource passports, and structured deconstruction can enable high-value reuse within the constraints of a functioning airport environment.

Old situation gate



Predemolition audit, 3D scan and passports



Work in Progress

New situation gate

- **Total avoided carbon: 54.4 tonnes of CO_2e**
- **Cost savings on sourcing: 155,661€**
- **Total mass of reused products: 21.5 tonnes**

CASE: REUSE OF GATE FOP49, AVINOR OSLO AIRPORT

How this case links to the framework

This case shows how structured data and early assessment can turn refurbishment and transformation into high-value reuse opportunities—rather than default replacement.

Key principles illustrated:

- Circular Design: Informing design and engineering decisions through early material inventories and passports
- Smart Use & Transformation: Prioritising reuse and refurbishment of existing assets before new build
- High-Value Deconstruction: Controlled dismantling supported by audits, labelling, and tracking

What to take into your next project:

Reuse at scale requires visibility and traceability before dismantling starts. When data, design, and delivery are aligned early, reuse becomes a controllable and verifiable outcome—not a risk.


Toilets
Utgang Gates A,B,C,D,E
Utgang Gates F12-F28,F31
F28
F26
SOMMER-FERIEN STARTER HER!


4


Gate Gates E,F,G
Utgang Gates D1
Ankomst/Bagasjehall Arrivals/Baggage reclaim
Transfer innland Domestic transfer
Utgang Gates A,B,C
BIT

GLOSSARY

10R principles — A ranked set of circular strategies that prioritises preventing and reducing resource use first, then extending product life through reuse-oriented actions, with recycling and recovery as last resorts.

Adaptive reuse — Repurposing existing buildings or components for new functions instead of demolishing them, extending their useful life and preserving embodied material value.

Asset lifecycle — The complete sequence of stages an asset passes through: design, construction, operation, maintenance, deconstruction, and potential reuse.

BIM (Building Information Modelling) — A digital process and data environment for creating and managing asset information across the lifecycle; can support material documentation and passports.

Build less (necessity check) — A decision step that challenges whether new construction is needed and prioritises reuse/refurbishment of existing assets first.

Building Circularity Index (BCI) — A building-level metric that indicates circular performance based on design and material choices, enabling early steering and comparison between project options.

Circular brief — A project brief that embeds circular objectives, roles, targets, data requirements, and airport constraints from the start.

Circular construction — A building approach that keeps materials in use at their highest value by designing for reuse, minimising waste, and managing resources across multiple lifecycles.

Circular procurement — Purchasing and contracting that embeds circular criteria (reuse, take-back, low-carbon materials, data reporting) into tenders, evaluation, and contracts.

Circular targets — Measurable goals for circular performance (e.g., % reused materials, CO_2e reduction, waste diversion) set at project or portfolio level.

Clean Site Charter — A set of on-site rules and expectations to prevent waste, separate material streams, manage logistics, and verify circular performance during construction.

Compliance — Adherence to applicable regulations, standards, and internal requirements governing airport projects.

Contamination rate — The share of incorrectly sorted materials in a waste or reuse stream; high contamination reduces reuse/recycling quality.

CO_2e (carbon dioxide equivalent) — A unit that expresses greenhouse gas emissions in terms of the amount of CO_2 that would have the same warming effect.

Deconstruction — A planned, controlled process of dismantling to recover components and materials at the highest possible value, as opposed to conventional demolition.

GLOSSARY

Design for disassembly (DfD) — A design strategy that enables buildings and components to be systematically taken apart, facilitating material recovery and reuse at end-of-life.

Donor building — An existing building or asset scheduled for renovation/demolition that provides components/materials for reuse in another project.

Embodied carbon — The total greenhouse gas emissions from extracting, manufacturing, transporting, and installing building materials.

Embodied emissions — Greenhouse gas emissions associated with materials and construction processes (often reported as embodied carbon/CO_2e).

ESG (Environmental, Social and Governance) — A set of criteria used to assess sustainability and governance performance; often used in reporting and investment decisions.

HSE (Health, Safety & Environment) — A function responsible for health, safety, and environmental management and compliance in projects and operations.

Intensity of Use (IU) ratio — A metric to assess how intensively a space/asset is used over time, supporting decisions to optimise existing assets before building new.

KPI (Key Performance Indicator) — A measurable indicator used to track progress toward targets (e.g., tonnes reused, CO_2e avoided, waste diversion).

Lifecycle assessment (LCA) — A standardised method for quantifying environmental impacts across a product's or building's entire life, from raw material extraction to disposal or reuse.

Material Circularity Indicator (MCI) — A circularity metric that scores how circular a product's material flows are by assessing input sources and end of use outcomes to support design and procurement decisions.

Material passport — A digital record of a product/component's materials, composition, performance, and history to enable traceability, reuse, and recovery.

Modularity — A design approach using standardised, interchangeable components that simplify adaptation, replacement, and reuse.

Non-toxic materials — Materials that avoid hazardous substances that hinder safe reuse, recycling, or indoor air quality performance.

Passport coverage — The share of key components/assemblies documented with sufficient material data (often via BIM/passports) to enable future reuse decisions.

Post-project evaluation — A structured review after completion to verify outcomes (reuse, CO_2e, cost) and capture lessons to improve the next project.

GLOSSARY

Pre-demolition audit — A systematic survey conducted before demolition to catalogue material quantities, conditions, and reuse potential.

Predictive maintenance — Maintenance that uses data to predict failures and schedule interventions before breakdowns, extending asset life.

Prefabrication — Off-site manufacturing of components/assemblies to improve quality and reduce on-site waste and time.

Procurement criteria (circular criteria) — Requirements used to evaluate tenders and contracts based on circular performance (reuse %, take-back, CO_2e, data reporting).

Refurbishment — Upgrading or renewing an existing asset to extend its service life and avoid replacement.

Reuse manager — A designated role responsible for planning, coordinating, tracking, and reporting reuse in a project.

Reuse pathway — A defined route for recovered materials/components (internal reuse, resale, refurbishment, donation, recycling) prioritising highest value use.

Reverse logistics — The systems and processes for returning used materials or components to suppliers or processors for reuse, refurbishment, or recycling.

Selective dismantling — The methodical disassembly of a building to recover materials in reusable condition, as distinct from conventional demolition.

Total cost of ownership (TCO) — The cumulative cost of an asset over its full lifecycle, encompassing acquisition, operation, maintenance, and end-of-life processing.

Value Hill — A model that shows how value is created during production and typically decreases after use, helping teams prioritise strategies that keep products, components, and materials at their highest value for longer.

Waste diversion rate — The share of waste diverted from landfill/incineration to reuse or recycling streams.

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FOR MORE INFORMATION, PLEASE REACH OUT TO:

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