SAEA Fall Convention September 19, 2026

REBUILDING SYRIA FROM THE RUBBLE

A Recycled Concrete Aggregate Framework for Reconstruction & Infrastructure



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Executive message

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Syria has an unusually large local feedstock of concrete demolition debris created by conflict and the 2023 earthquake.

RCA can convert demolition waste into a useful construction resource.

Principal technical issues are higher absorption and porosity, lower density and stiffness, and greater variability.

RCA is not a drop-in substitute for natural aggregate. It is an engineered material whose value depends on source quality, processing, testing, and application.

Post-conflict reconstruction requires rapid, scalable, and resource-efficient solutions.

2

The Reconstruction Constraint & Logistics

Constraint

High demand for housing and infrastructure

Damaged roads, disrupted supply chains, expensive fuel, limited landfill capacity

Opportunity

Concrete debris is generated where reconstruction demand exists

Near-site processing avoids hauling waste out and virgin aggregate in

The Scale of the Challenge

- **>130,000 buildings destroyed; ~ 50M m^3 of rubble (Minister of Emergency & Disaster Management)**
- **3M m^3 removed in first 8 months of 2026 (~6%)**
- **Damaged roads, disrupted supply chains, expensive fuel, limited landfill capacity**
- **~70% of destroyed buildings were RC**



Rubble is not only a waste-management problem – It is a reconstruction resource.

Why RCA matters for Syria

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Concrete debris is generated exactly where reconstruction demand exists

RCA converts demolition waste into a useful construction resource

Near-site processing avoids hauling waste out and virgin aggregate in

20–30%
typical RCA material-cost advantage vs. natural aggregate

40–60%
potential C&D waste diversion from landfills

20–50%
Potential CO_2 reduction versus conventional natural-aggregate mixtures

2

Why RCA matters for Syria

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Rebuild faster

Process material close to damaged districts and reduce hauling

Reduce import dependence

Use a locally available aggregate source while supply chains recover

Create circular infrastructure

Move from rubble → aggregate → new infrastructure → future recycling

2

SECTION 2

What RCA is & How it differs



A Syria-specific recycled concrete framework

RCA differs from natural aggregate because adhered mortar remains attached to the original aggregate.

- Particle density: ~2,100–2,500 kg/m^3 (RCA) vs. 2,600–2,800 kg/m^3 (natural)
- Higher absorption and porosity, lower density and stiffness, greater variability
- Water absorption: typically 3–10%+ (RCA) vs. ~0.5–4% (natural)



These differences can be managed through source characterization, processing, mixture design, and QA/QC.

Typical RCA: lower density + higher absorption + higher porosity + greater variability

Replacement level matters

Moderate replacement often provides the best balance

≤30%
Typically minimal performance loss

30–70%
Careful mixture design required

>70%
Strength/durability effects become more significant

Compressive strength
Reductions commonly ~5–24%

Elastic modulus
~10% lower at 50% RCA; up to ~35% at 100%

Abrasion resistance
LA loss often ~30–50% higher

For seismic and critical infrastructure, specify RCA by performance and exposure — not by a generic percentage alone

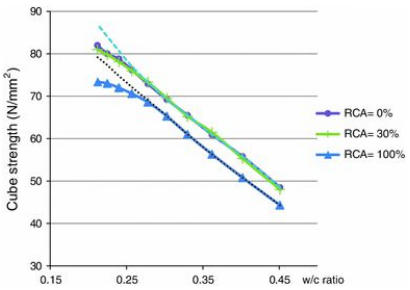
Durability and volumetric behavior

Carbonation, chloride, and sulfate ingress can increasee when porosity and ITZ effects are not controlled.

Freeze-thaw performance depends on concrete quality and appropriate air entrainment.

Alkali–aggregate reactivity requires source evaluation – the original concrete may have been reactive.

RCA concrete is reported to have higher shrinkage and creep; fine RCA tends to increase shrinkage further.



Primary mitigation: lower w/cm + SCMs + appropriate air entrainment + adequate cover + source-specific testing

True recycling vs. downcycling

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DOWNCYCLING

Road base
Subgrade improvement
Drainage layers
Backfill
Landscaping / erosion control

TRUE RECYCLING

RCA in new concrete
Preserves more material value
Supports higher-value circularity
Requires stronger characterization and QA/QC

Both are valid: The strategic mistake is burying usable material or assuming all crushed concrete is structural-grade RCA.

Tiered market maximizes value: Structural → pavement → non-structural → granular uses

SECTION 3

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The RCA Framework



A Syria-specific recycled concrete framework

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A material-management system — not a single recycling plant

QA/QC

DEMOLITION
Selective & safe

→

SEGREGATION
Remove hazardous & foreign materials

→

PROCESSING
Crush • screen • separate

→

REUSE
Aggregate returns to service

→

RECONSTRUCTION
Roads • water • buildings

Principle: quality begins before the first crusher

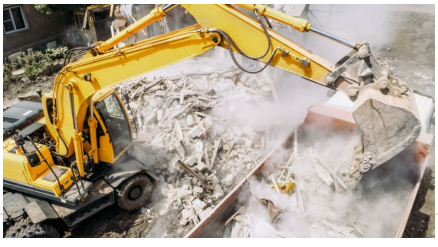
The framework deliberately moves from immediate, lower-risk applications toward higher-value structural reuse as processing and testing capacity mature

Step 1 — Safe recovery of concrete debris

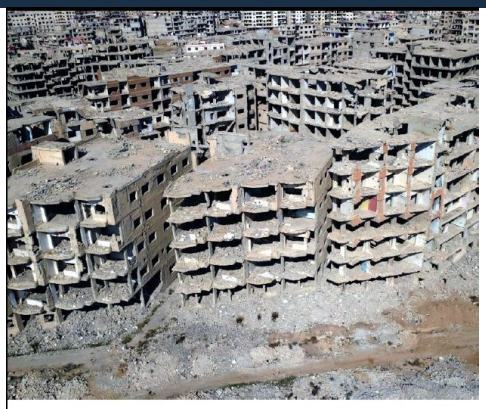
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1. **Map & assess**
   Identify demolition zones, access constraints and unstable structures.
   Darayya Report by SAEA
2. **Selective demolition**
   Separate concrete from wood, plastics, asphalt, soil and hazardous materials.
3. **Remove reinforcement**
   Cut or remove reinforcing steel before or during processing.
4. **Segregate at source**
   Basic sorting substantially improves RCA purity and reduces downstream processing.
5. **Control hazards**
   Unexploded ordnance, dust, unstable structures and worker exposure are project constraints.
6. **Route material**
   Choose mobile crushing, temporary fixed processing or centralized plants.





Darayya Report



تقرير المسح الأولي لواقع تضرر المباني في سوريا

مدينة داريا - ريف دمشق

نيسان 2025

دراسة مقدمة لنقابة المهندسين في سوريا

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https://saea-us.org/damage-surveying/

Step 2 — Match the processing system to the reconstruction need

MOBILE / NEAR-SITE



Best for

Road base • fill • emergency access

Lowest hauling burden

ON-SITE STATIONARY



Best for

Higher throughput • better process control

Middle-ground solution

PERMANENT CENTRAL PLANT



Best for

Higher-quality RCA • structural concrete

Highest processing control

Plant selection should follow the required end-use quality — not the other way around.

Step 3 — The RCA production line

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1. **Primary crushing**
   Jaw / impact; reduce large concrete sections
2. **Steel separation**
   Magnetic separation and removal of reinforcing steel
3. **Secondary / tertiary**
   Impact or cone crushing to target sizes
4. **Screening**
   Produce controlled gradations
5. **Air / manual / washing**
   Remove light and fine contaminants
6. **Stockpile & certify**
   Moisture, density, absorption, gradation, contaminants

Output: a classified, traceable engineered material — not simply crushed rubble.

Structural applications require routine verification — not one-time acceptance

Source: Report, Sections 3.1–3.4.

A tiered application strategy de-risks reconstruction

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TIER 1 Immediate	**Fill • embankments • temporary roads** Minimal processing	→ **Fastest path to visible recovery**
TIER 2 6–12 months	**Road base • subbase • drainage** Basic crushing + gradation	→ **Rebuild transport and drainage**
TIER 3 1–2 years	**Sidewalks • curbs • blocks • non-structural concrete** Controlled crushing + contaminant screening	→ **Visible neighborhood reconstruction**
TIER 4 With investment	**Structural concrete — potentially up to 50% replacement** Full characterization + SCMs + QA/QC	→ **Highest-value circularity**

Do not wait for perfect conditions. Start with safe, useful applications and build capacity upward.

Progressive qualification: Experience and quality systems grow with application risk

Infrastructure priority #1 — Roads and transport

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Why roads first

Road access unlocks demolition, aid delivery, utility repair, housing reconstruction and economic activity

Where RCA fits

20–50 mm RCA is identified for unbound road base/subbase. Rigid pavements can use RCA when material and mixture are qualified

Engineering controls

Account for abrasion, soundness, AAR, thermal properties and source variability; use mechanistic-empirical pavement design where applicable

Reconstruction logic: restore mobility → restore supply chains → accelerate rebuilding.

Infrastructure priority #2 — Water, drainage and flood resilience

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RCA can support water-infrastructure recovery — but water quality must be designed into the recycling system.

Useful applications

Drainage fill
Utility corridors
Engineered fill
Selected civil works

Key risk

RCA stockpiles can generate high-pH runoff and may contain trace metals

Control strategy

Locate away from critical watercourses; use berms, sediment controls, pH monitoring and appropriate treatment

The recycling system must help rebuild Syria's water network — not create a new water-quality problem.

Infrastructure priority #3 — Buildings and neighborhood reconstruction

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SIDEWALKS / CURBS

Controlled RCA concrete

BLOCKS / NON-STRUCTURAL

Screened, consistent material

FOUNDATION / FILL

Engineered fill where appropriate

STRUCTURAL CONCRETE

Qualified RCA + performance-based design

The objective is not maximum RCA content. The objective is maximum safe recovery value

Higher-value uses require higher-quality feedstock and tighter quality assurance

Environmental safeguards are part of the framework

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DUST / SILICA

Water sprays • enclosed cabs • speed control • wind protocols

ALKALINE RUNOFF

Drainage controls • berms • pH monitoring • treatment

NOISE / COMMUNITY

Site selection • operating controls • monitoring

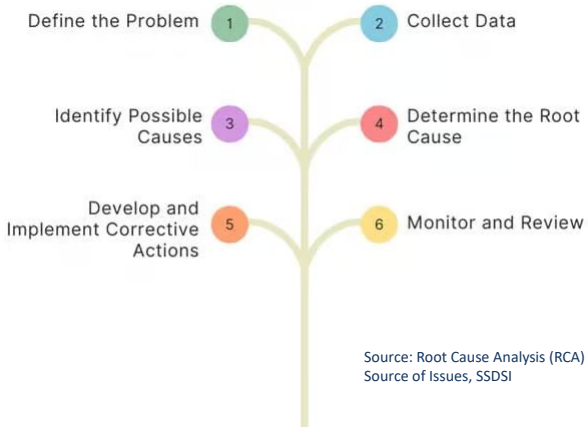
RESIDUAL WASTE

Segregation • beneficial reuse • controlled disposal

Syria's post-conflict context makes environmental controls a reconstruction requirement, not an optional add-on

SECTION 4

ECONOMICS, STANDARDS, & IMPLEMENTATION



Source: Root Cause Analysis (RCA) Explained: Finding the True Source of Issues, SSDSI

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Economics — the value is in the whole logistics chain

Material cost

Typical RCA material costs 20–30% below natural aggregate

Transport & disposal

Near-site processing can avoid hauling demolition waste away and virgin aggregate back to the city

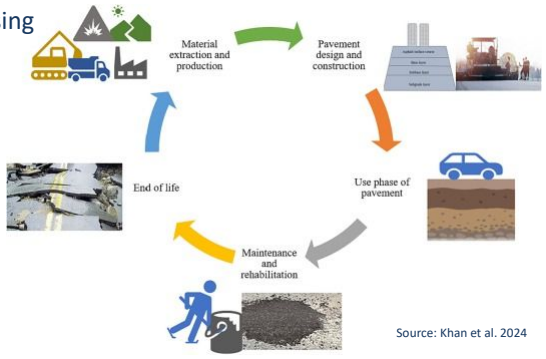
Project economics

Reported whole-project savings can be larger than unit-price savings because disposal, transport and logistics are included

Economics — the value is in the whole logistics chain

What drives RCA economics:

- Hauling distance to demolition sites and processing plants
- Cost of landfill disposal and tipping fees
- Value and availability of natural aggregate
- Plant capital and operating costs
- Steel recovery value
- Quality-control and laboratory costs
- Distance between RCA production and end-use projects



Source: Khan et al. 2024

Best economic fit: Urban demolition + nearby reconstruction demand + adequate processing quality

Standards: adapt an international framework; build Syrian capacity

ASTM C33 + companion tests	Aggregate grading / quality; RCA-specific evaluation still required
AASHTO M 80 • R 80 • T 96 • T 336 • M 319	Highway materials, reactivity, abrasion, thermal properties and reclaimed concrete applications
EUROPE EN 12620 • EN 13242	Recycled aggregate classification for concrete and civil engineering
SYRIA Current gap identified	No dedicated RCA standard General Syrian code does not address RCA-specific variability

Near-term policy action: issue an interim Syrian RCA specification adapted from ASTM / AASHTO / EN, with local acceptance criteria

Classification by application and quality level can make implementation manageable.

Public sector projects controlled pilot environments for qualifications and data collection.

Barriers to Implementation

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TECHNICAL

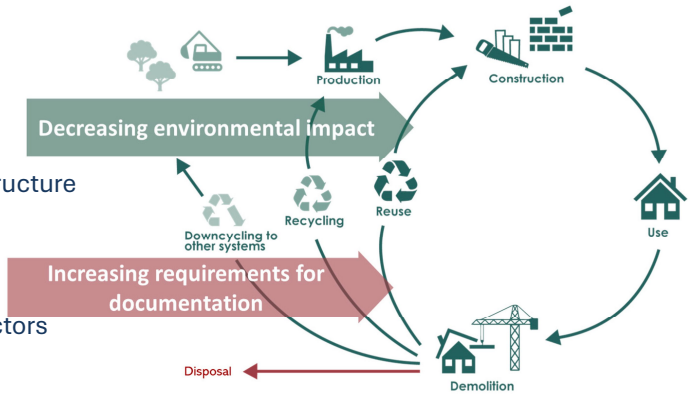
- Variable feedstock quality
- Insufficient source separation
- Limited processing and laboratory infrastructure

MARKET/INSTITUTIONAL

- No established RCA specifications
- Uncertainty among designers and contractors
- Fragmented transport and market

CAPACITY

- Need for training, field demonstrations, performance data, and consistent QA/QC



Source Ottosen et al. 2024

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Institutional framework — who must make it work

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NATIONAL GOVERNMENT

Policy • procurement • standards • permitting

MUNICIPALITIES

Debris mapping • site access • local logistics

ENGINEERS / UNIVERSITIES

Testing • mixture design • training • research

CONTRACTORS / PRODUCERS

Processing • QA/QC • traceability • delivery

DONORS / UN / DEVELOPMENT

Pilot funding • capacity building • monitoring

COMMUNITIES

Safety • nuisance controls • local employment

The report identifies institutional barriers — specification inertia, limited familiarity and inconsistent QA/QC — as major constraints

Pilot program — prove the framework in real reconstruction

1	**CITY / DISTRICT**	Select a damaged district with substantial concrete debris and an active reconstruction need.
2	**FEEDSTOCK**	Characterize source concrete; segregate hazardous and non-concrete materials.
3	**PROCESSING**	Deploy mobile or temporary fixed crushing with controlled screening and separation.
4	**PRODUCTS**	Produce road base, drainage aggregate, blocks/curbs and selected concrete mixes.
5	**MONITORING**	Track cost, production, gradation, absorption, strength, dust, runoff and user feedback.
6	**SCALE-UP**	Use verified results to expand plant capacity and move into higher-value applications.

Demonstration element: Construct a monitored demonstration element or pavement section. Record costs, construction observations, and performance for future specification development

KPIs for a Syrian RCA reconstruction program

MATERIAL

tons of concrete recovered; % accepted as RCA

INFRASTRUCTURE

km of road base/pavement supported; m^3 drainage / fill

QUALITY

lot acceptance rate; absorption; gradation; strength compliance

ECONOMICS

$/ton delivered; avoided haulage; avoided disposal; project savings

ENVIRONMENT

landfill diversion; virgin aggregate avoided; fuel/CO_2 reduction

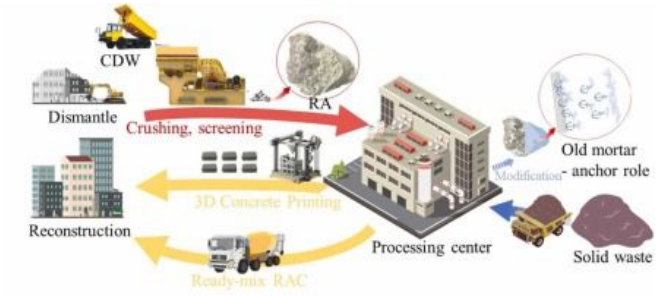
SOCIAL

local jobs; worker safety; community complaints; training completed

What gets measured can become a national evidence base for the next generation of specifications.

Section 5

VISION, ACTIONS, & CONCLUSIONS



Source: Lei et al. Elsevier 2024

A tiered strategy for Syria

Six actions to move forward

1. Develop a formal RCA standard/specification framework
2. Encourage recycled content in appropriate public projects
3. Launch representative pilot projects
4. Invest in plants, laboratories, and QA/QC systems
5. Train engineers, contractors, operators, and testing personnel
6. Track long-term field performance and refine specifications



Source: UNDP.org/blog/clearing-way-syrias-recovery

Implementation roadmap — from emergency recovery to circular construction

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0–6 MONTHS

Establish governance
Map debris
Safety protocols
Launch mobile crushing pilots

6–12 MONTHS

Road base / drainage
Basic labs
Material classes
Public-project specifications

1–2 YEARS

Non-structural concrete
Permanent/temporary plants
Engineer training
Pilot structural mixes

3–5 YEARS

National RCA standard
Structural infrastructure
Performance database
Advanced treatment

The roadmap is intentionally incremental: capacity and confidence rise together.

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Long-term vision — a circular Syrian construction system

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RCA becomes part of the construction system — not a temporary response to war debris.

BUILD
Concrete infrastructure

USE
Homes • roads • utilities

RECOVER
Selective demolition

PROCESS
RCA + steel recovery

DESIGN
Design for future reuse

REBUILD
New infrastructure

Conclusions

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- Large debris volumes create a potentially significant local aggregate resource
- RCA is technically viable for a broad range of applications when appropriately processed and characterized
- Successful implementation depends on processing quality, contaminant control, characterization, moisture management, and performance-based mixture design
- Proper engineering design can produce RCA concrete with performance comparable to conventional materials
- RCA is presented as a practical and scalable solution for Syria's reconstruction
- Syria can benefit from a phased approach that begins with lower-risk uses and progresses toward higher-value applications

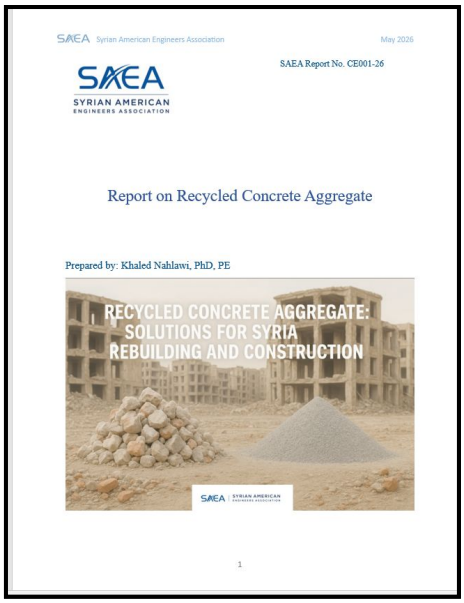
The road ahead

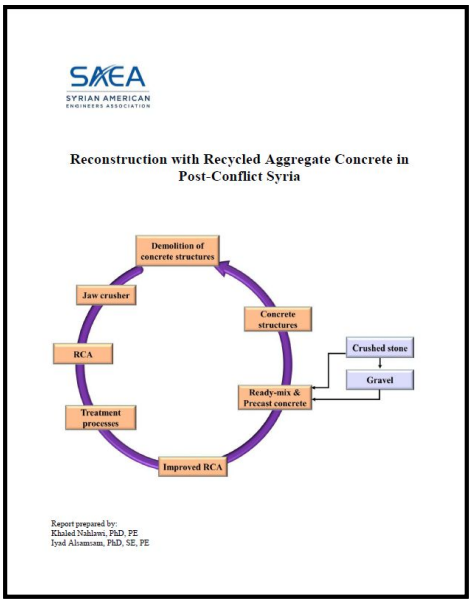
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- Build a practical standard
- Create reliable processing and testing capacity
- Demonstrate performance through pilot projects
- Use public projects to establish demand and confidence
- Capture field data and continuously improve the specifications

The long-term objective is a functioning circular construction-material market

SAEA Report





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For SAEA | Submission and dissemination

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Formal Submission of the Report

Submit the report to the engineering syndicate, relevant government agencies, and key reconstruction stakeholders.

Dissemination and Awareness

Share the findings with decision-makers so RCA can be considered in reconstruction planning and project delivery.

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Submission, Dissemination, and Next Steps for SAEA

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Next Steps for SAEA

- **Support a pilot project.** Provide institutional and technical support for a representative pilot project to demonstrate the viability of RCA in Syrian reconstruction
- **Support local agencies in the use of RCA.** Assist local organizations and agencies in adopting and applying RCA in appropriate applications
- **Develop an implementation roadmap and training program for engineers, contractors, and plant operators**
- **Establish a QA/QC framework.** Create a QA/QC system to ensure consistent material quality, traceability, and compliance with accepted standards
- **Define testing and acceptance protocols for Syria**
- **Support publication of Syria-specific specifications.** Assist authorities/engineering syndicate in drafting and publishing technical specifications adapted to local conditions, materials, and reconstruction requirements

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THE OPPORTUNITY

Turn the debris of war into an asset for reconstruction.

RCA is not a standalone solution.
It is a strategic component of resilient Syrian reconstruction



Source: Facebook: The New Arab