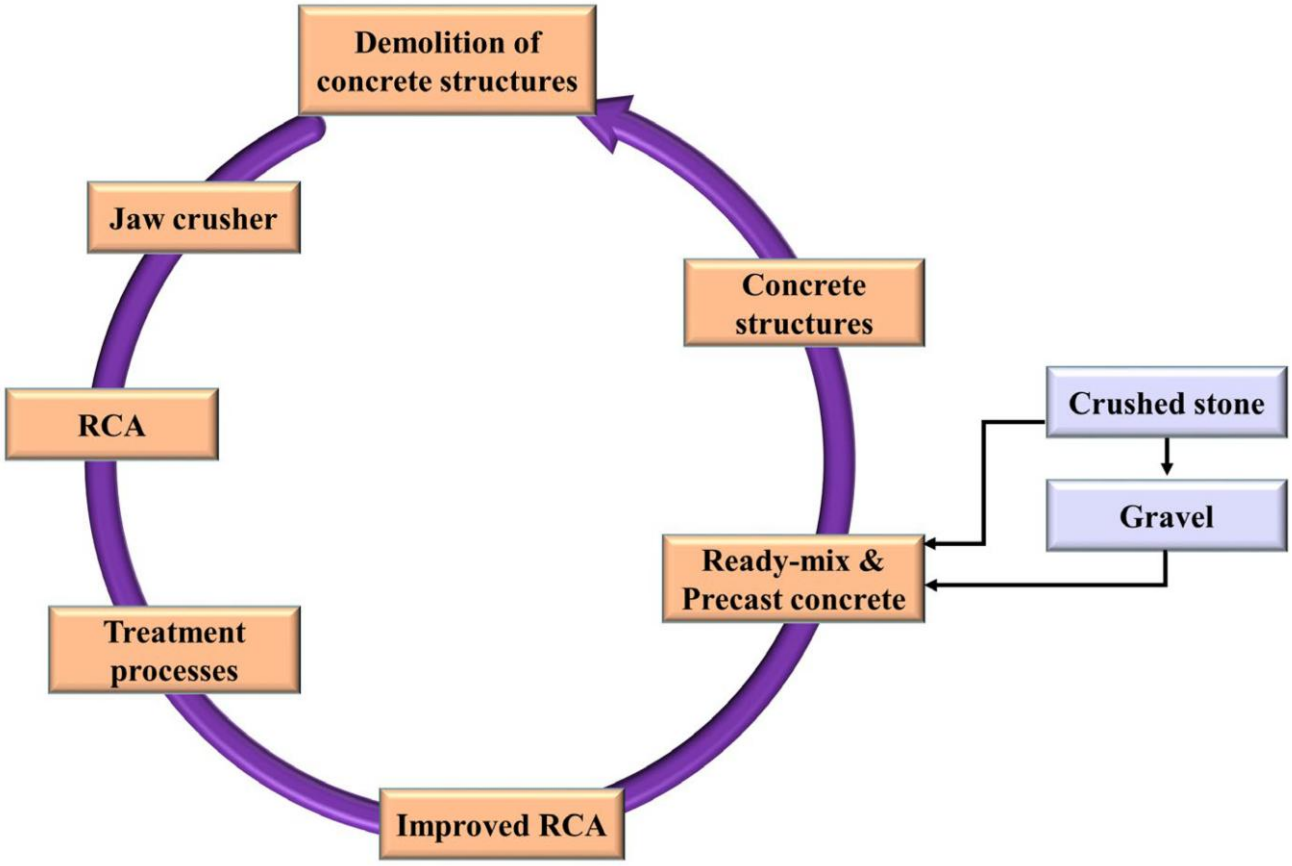
SYRIAN AMERICAN ENGINEERS ASSOCIATION

Reconstruction with Recycled Aggregate Concrete in Post-Conflict Syria



Report prepared by:
Khaled Nahlawi, PhD, PE
Iyad Alsamsam, PhD, SE, PE

Introduction

The reconstruction of Syria must follow a framework built on five guiding principles: prioritize stability before large-scale development, empower Syrians to lead rebuilding efforts, work within political and sanctions-related realities, focus first on creating jobs and livelihoods, and ensure transparency through decentralized decision-making.

During the first two years, the emphasis is on restoring essential services such as water, electricity, healthcare, and schools at the neighborhood level through repair-focused projects and cash-for-work programs that provide immediate employment. Pilot "reconstruction safe zones" would demonstrate effective governance, donor accountability, and legal clarity, while mobilizing the Syrian diaspora through bonds, remittances, and co-investment mechanisms to support housing and community recovery.

From years two to ten, the strategy shifts toward economic revitalization and sustainable investment. Long-term success depends on many factors. Developing transparent public-private partnerships in infrastructure such as power, water, and logistics is among the most important. Ultimately, success is measured not by rapid modernization but by practical outcomes: people employed, children educated, reliable basic services, local food production, and the voluntary return of refugees over a decade-long recovery effort. In this recovery, the massive amounts of rubble created by war and destruction can and must be used as recycled concrete aggregates (RCA). RCA will secure local material resources for reconstruction and to serve as sustainable resources that create trust in the public sector by securing jobs and income for workers while motivating businesses to grow and prosper.

This document provides a detailed roadmap authored by the Syrian American Engineers Association (SAEA) for Syria and Syrians to implement using the following four chapters:

Chapter 1: Roadmap for using Recycled Concrete Aggregates
Chapter 2: Step-by-Step Implementation Plan for Syrian Cities
Chapter 3: Pilot Implementation Example for RCA in Aleppo
Chapter 4: Foundational Principles to Guide the Roadmap Implementation

Roadmap for Using Recycled Concrete Aggregate

Roadmap Objectives

This roadmap aims to:

(a) Accelerate physical reconstruction

(b) Reduce material and transport costs

(c) Convert war debris into construction resources

(d) Build local technical and institutional capacity

(e) Transition toward a circular reconstruction model

The roadmap is **phased, scalable, and adaptable** to cities such as **Aleppo**, **Homs**, **Damascus**, and similar urban centers. It also comes with a sample step-by-step implementation plan and a guiding pilot example using the city of Aleppo.

Phase 1 – Emergency Stabilization & Planning (0–6 Months)

Key Goals

(a) Clear priority debris

(b) Restore basic access and services

(c) Establish institutional control

Actions

(a) Form municipal reconstruction and RCA coordination units

(b) Identify priority districts (housing, hospitals, roads)

(c) Issue temporary guidelines allowing RCA use

(d) Launch pilot debris-to-material operations

Outputs

(a) Debris mapping and material inventory

(b) Temporary RCA approval framework

(c) First recycled materials available for use

Phase 2 – Early Recovery & Pilot Reconstruction (6–18 Months)

Key Goals

(a) Demonstrate RCA feasibility

(b) Reduce reliance on imported aggregates

(c) Rebuild basic urban functions

Actions

(d) Deploy mobile crushing units in damaged districts

(e) Use RCA in:

a. Road sub-base

b. Utility trenches

c. Sidewalks and pavements

(f) Train municipal engineers and contractors

(g) Mandate RCA use in publicly funded projects

Outputs

(a) Operational RCA pilot projects

(b) Measured cost and time savings

(c) Local workforce trained

Phase 3 – Scaling & Standardization (1.5–3 Years)

Key Goals

(a) Expand RCA use city-wide

(b) Improve quality and consistency

(c) Formalize technical practices

Actions

(a) Establish semi-centralized recycling yards

(b) Introduce simplified technical standards

(c) Increase RCA replacement ratios for approved uses

(d) Integrate RCA requirements into tender documents

Outputs

(a) Stable RCA supply chains

(b) City-level technical guidelines

(c) Reduced landfill dependency

Phase 4 – Structural Reconstruction & Housing Expansion (3–6 Years)

Key Goals

(a) Support large-scale housing and infrastructure programs

(b) Balance speed, safety, and durability

Actions

(a) Use RCA in:

a. Foundations for low-rise housing

b. Public buildings (schools, clinics)

c. Drainage and retaining structures

(b) Introduce basic material testing capacity

(c) Promote private-sector RCA adoption

Outputs

(a) Affordable housing delivered at scale

(b) Improved material confidence

(c) Stronger local construction sector

Phase 5 – Institutionalization & Circular Construction (6–10 Years)

Key Goals

(a) Embed sustainability into reconstruction policy

(b) Reduce long-term material imports

(c) Align with future development goals

Actions

(a) Enact permanent RCA regulations

(b) Establish permanent recycling facilities

(c) Promote RCA-based blocks and precast elements

(d) Link donor funding to circular construction principles

Outputs

(a) Fully integrated circular construction system

(b) Long-term cost and environmental savings

(c) Institutional resilience

Cross-Cutting Enablers (All Phases)

Governance

(a) Clear municipal authority

(b) Transparent procurement

(c) Anti-corruption safeguards

Finance

(a) Donor grants for equipment

(b) Public-private partnerships

(c) Incentives for local recyclers

Capacity Building

(a) Short technical trainings

(b) Field manuals in Arabic

(c) Knowledge sharing between cities

Social Impact

(a) Local job creation

(b) Community engagement

(c) Visible recovery progress

Risk Management

Risk	**Mitigation**
Material contamination	Visual screening + restricted use
Low technical capacity	Simple standards + training
Resistance from contractors	Mandatory use in public works
Funding gaps	Phased implementation

Strategic Message

For Syria, reconstruction is not only about rebuilding structures—it is about **rebuilding systems**.
RCA enables a **resource-efficient, locally driven, and scalable recovery pathway**, turning destruction into the foundation for renewal.

Step-by-Step RCA Implementation Plan for Syrian Cities

Introduction

This is an implementation guide with a step-by-step approach to using RCA as part of a Practical Reconstruction Framework. The foundational principles for the suggested reconstruction framework are described in detail at the end of this document.

This implementation guide applies to cities such as Aleppo, Homs, Damascus, Deir ez-Zor, and similar urban areas of various sizes and levels of war-related destruction.

Phase 1 – Institutional Setup and Governance (0–3 months)

Step 1: Establish a City RCA Task Force

Each city or governorate should create an **RCA Task Force** composed of:

(a) Municipality engineering department

(b) Public works or housing authority

(c) Local contractors' representative

(d) Environmental or debris management unit

(e) NGO or donor technical advisor (if applicable)

Task Force Responsibilities

(a) Select and prioritize districts for RCA collection or high Approve RCA use zones and applications

(b) Coordinate debris clearance and recycling

(c) Define basic technical rules (fit-for-purpose standards)

Step 2: Define RCA Policy and Priority Uses

Given current conditions in **Syria**, RCA should be **mandatory or strongly encouraged** for:
Priority applications

(a) Road and street sub-base

(b) Backfill for utilities

(c) Sidewalks, curbs, drainage channels

(d) Foundations for low-rise housing

(e) Public buildings (schools, clinics) – non-critical elements
Restricted applications

(a) High-rise buildings

(b) Prestressed or seismic-critical elements (unless tested)

Phase 2 – Debris Mapping and Material Assessment (1–3 months, parallel)

Step 3: Map Concrete Debris Sources

Conduct a **rapid debris inventory**:

(a) Identify heavily damaged districts

(b) Classify debris by type:

a. Reinforced concrete

b. Masonry/brick

c. Mixed rubble

Output

(a) City debris map

(b) Estimated recoverable concrete volume

(c) Priority recycling zones

Step 4: Select Suitable Debris for RCA Acceptable sources

(a) Residential and commercial RC buildings

(b) Pavements, slabs, foundations

Avoid or restrict

(a) Industrial facilities

(b) Chemical plants

(c) Highly contaminated military sites

Simple **visual screening** is sufficient at this stage.

Phase 3 – Infrastructure and Equipment Setup (2–6 months)

Step 5: Choose RCA Production Model

Option A – Mobile On-Site Crushing (Early Recovery)

Best for:

(a) Severely damaged districts

(b) Road rehabilitation

(c) Emergency

housing Equipment:

(a) Mobile jaw crusher

(b) Simple screen

(c) Excavator with magnet attachment

Option B – Semi-Centralized City Recycling Yard

Best for:

(a) Medium-term reconstruction

(b) Concrete production

(c) Multiple neighborhoods

Location:

(a) Edge of city

(b) Near debris concentration

(c) Away from residential zones

Step 6: Basic Production Flow

(a) Debris collection and sorting

(b) Removal of reinforcement steel (sell or store separately)

(c) Primary crushing

(d) Screening into:

a. Coarse RCA (base, concrete)

b. Fines (fill, backfill)

No advanced laboratory testing required initially

Phase 4 – Quality Control (Fit-for-Purpose Approach)

Step 7: Apply Simple Acceptance Criteria

Instead of international standards, use **practical Syrian criteria**:

Application	**Max RCA Content**	**Control Method**
Road sub-base	100%	Visual + grading
Backfill	100%	Visual
Sidewalk concrete	30–50%	Trial mix
Housing foundations	≤ 30%	Trial mix
Structural elements	≤ 25%	Engineer approval

Step 8: Moisture and Workability Control

To manage higher absorption:

(a) Pre-wet RCA before mixing

(b) Avoid adding extra water on site

(c) Use plasticizers where available

Phase 5 – Integration into Reconstruction Projects Step

9: Mandatory RCA Use in Public Projects

Municipalities should require RCA use in:

(a) Road repairs

(b) Public housing

(c) Schools and clinics

(d) Infrastructure trenches

This creates **guaranteed demand** and stabilizes production.

Step 10: Support Private Sector Adoption

Encourage private builders by:

(a) Lower RCA prices

(b) Priority access to recycled materials

(c) Fast-track permits for RCA-based projects

Phase 6 – Workforce and Community Engagement

Step 11: Local Labor Training

Provide **short practical training** (1–2 days) for:

(a) Crusher operators

(b) Site engineers

(c) Concrete workers

Focus on:

(a) Proper sorting

(b) Moisture control

(c) Safe handling

Step 12: Community Participation

Benefits:

(a) Employment for debris removal

(b) Cleaner neighborhoods

(c) Visible reconstruction progress

Local communities should be involved in:

(a) Manual sorting

(b) Site monitoring

(c) Reporting contamination

Phase 7 – Environmental and Safety Controls Step

Step 13: Dust and Noise Management

(a) Water spraying during crushing

(b) Limited operating hours near housing

(c) Simple barriers where possible

Step 14: Manage Fine RCA and Waste

(a) Use fines for backfill and leveling

(b) Avoid uncontrolled dumping

(c) Reuse wash water where possible

Phase 8 – Monitoring, Scaling, and Institutionalization

Step 15: Monitor Performance

Track:

(a) Cost savings

(b) Volume of debris recycled

(c) Reduction in quarry use

(d) Construction performance feedback

Step 16: Scale Up City-Wide

After successful pilots:

(a) Expand RCA yards

(b) Increase replacement limits

(c) Introduce basic testing labs (long term)

(d)

Phase 9 – Long-Term Integration (3–10 years)

Step 17: Integrate RCA into Syrian Reconstruction Policy

(a) Include RCA in municipal bylaws

(b) Standardize mix proportions

(c) Link RCA use to donor funding conditions

Step 18: Transition to Circular Construction

Long-term goals:

(a) Permanent recycling facilities

(b) RCA blocks and precast units

(c) Reduced dependence on imports

(d) Sustainable urban rebuilding

Final Recommendations

For Syria, **RCA is not a secondary option—it is a reconstruction necessity**.
This step-by-step plan prioritizes:

(a) Speed

(b) Cost efficiency

(c) Local capacity

(d) Safety without over-regulation

Pilot Roadmap Implementation Example for RCA in Aleppo

1. Pilot City Rationale

Aleppo experienced extensive destruction of residential neighborhoods, industrial zones, road networks, and public facilities. Large volumes of reinforced concrete debris are concentrated within and around the city, while access to high-quality virgin aggregates is constrained by cost, transport distance, and fuel availability.

Aleppo is therefore an ideal **pilot city** to demonstrate how RCA can:

(a) Accelerate debris clearance

(b) Reduce reconstruction costs

(c) Support affordable housing

(d) Build local reconstruction capacity

Success in Aleppo can later be replicated in other Syrian cities.

2. Pilot Objectives (Aleppo-Specific)

Primary objectives

(a) Convert ≥40% of concrete debris into usable RCA within 3 years

(b) Reduce aggregate procurement costs by ≥30%

(c) Restore priority roads and housing using locally recycled materials

Secondary objectives

(a) Create local employment

(b) Reduce uncontrolled dumping

(c) Establish a replicable technical model

3. Pilot Area Selection (Months 0–3)

Priority District Criteria

(a) High concentration of concrete rubble

(b) Immediate need for housing and roads

(c) Safe access for equipment

Recommended pilot districts

(a) Eastern Aleppo residential areas

(b) Industrial access corridors

(c) Selected arterial roads connecting services

Outputs

(a) Debris inventory map

(b) Estimated RCA production volumes

(c) Approved pilot zones

4. Phase 1 – Institutional Setup & Governance (0–6 Months)

Key Actions

(a) Establish the **Aleppo RCA Task Force** within the municipality

(b) Issue a temporary municipal directive permitting RCA use

(c) Deploy **mobile crushing units** in pilot districts

(d) Begin debris sorting and steel recovery

RCA Applications

(a) Road sub-base layers (100% RCA)

(b) Utility trench backfill

(c) Temporary access roads

Deliverables

(a) First RCA stockpiles

(b) Cleared streets and access routes

(c) Documented cost savings

5. Phase 2 – Pilot Reconstruction Projects (6–18 Months)

Key Actions

(a) Construct sidewalks, curbs, and drainage using RCA concrete

(b) Rehabilitate local streets using RCA sub-base

(c) Build foundations for low-rise residential blocks (≤30% RCA)

(d) Train local contractors and engineers

Quality Control

(a) Visual inspection

(b) Trial concrete mixes

(c) Simple grading checks

Deliverables

(a) 3–5 completed pilot projects

(b) Trained local workforce

(c) Municipal RCA usage procedures

6. Phase 3 – Scaling & Semi-Centralized Recycling (1.5–3 Years)

Key Actions

(a) Establish **Aleppo Central Recycling Yard** (city edge)

(b) Integrate RCA clauses into municipal tenders

(c) Increase RCA use in public buildings (schools, clinics)

(d) Introduce basic testing capability

RCA Applications Expanded

(a) Housing foundations

(b) Retaining walls

(c) Public facilities (non-critical elements)

Deliverables

(a) Stable RCA supply chain

(b) Reduced landfill use

(c) Improved construction quality consistency

7. Phase 4 – Housing & Infrastructure Expansion (3–6 Years)

Key Actions

(a) Support large-scale housing programs using RCA

(b) Encourage private-sector RCA adoption

(c) Promote RCA-based blocks and precast elements

(d) Introduce incentives for recyclers and builders

Deliverables

(a) Affordable housing units delivered

(b) Lower reconstruction unit costs

(c) Strengthened local construction market

8. Phase 5 – Institutionalization & Replication (6–10 Years)

Key Actions

(a) Formalize RCA regulations in Aleppo municipality

(b) Establish permanent recycling facilities

(c) Share Aleppo experience nationally

(d) Support replication in other cities

Deliverables

(a) Long-term circular construction system

(b) Reduced reliance on imported materials

(c) National RCA framework

9. Monitoring & Key Performance Indicators (KPIs)

Indicator	**Target**
Concrete debris recycled	≥ 40%
Cost reduction	≥ 30%
Jobs created	≥ 500
Roads rehabilitated	≥ 50 km
Housing units supported	≥ 10,000

10. Risk Management (Aleppo Context)

Risk	**Mitigation**
Contaminated debris	Source screening
Fuel shortages	Localized crushing
Contractor resistance	Mandatory RCA in public works
Funding gaps	Phased donor support

11. Strategic Value of the Aleppo Pilot

This pilot transforms Aleppo from a symbol of destruction into a **model of resource-efficient reconstruction**.
By converting rubble into infrastructure, the city demonstrates how post-conflict recovery can be **faster, cheaper, and locally driven**.

Reconstruction Foundational Principles (What Must Guide this Roadmap)

1. **Stability before scale** – Small, visible successes build confidence faster than mega-projects.
2. **Local-first reconstruction** – Syrians rebuild Syria; external actors enable rather than replace.
3. **Political realism** – Work within constraints (sanctions, frozen diplomacy) while creating pathways forward.
4. **Economic dignity** – Jobs and income matter more than infrastructure at the start.
5. **Transparency & decentralization** – Reduce corruption risk by dispersing authority and funds.

Phase I (0–2 Years): Stabilization & Confidence Building

A. Prioritize Human Systems Over Physical Ones

Instead of starting with highways or megaprojects:

(a) Restore **water, electricity, healthcare, and schools** at the neighborhood level

(b) Focus on **repair**, not full reconstruction

(c) Use **cash-for-work** programs to employ locals in cleanup and basic rebuilding

Outcome: employment, reduced aid dependency, visible progress

B. Create "Reconstruction Safe Zones"

Designate pilot regions where:

(a) Property records are clarified

(b) Local councils manage reconstruction funds

(c) International NGOs can operate with legal clarity

(d) Sanctions exemptions are clearly applied

These zones serve as **proof of concept** for donors and investors.

C. Mobilize the Syrian Diaspora

Instead of traditional foreign investors:

(a) Offer **diaspora bonds**

(b) Enable **remittance-backed housing reconstruction**

(c) Create co-investment platforms where diaspora capital is matched by aid funds

Diaspora money is patient, emotionally motivated, and less risk-averse.

Phase II (2–5 Years): Economic Reactivation

A. Focus on Livelihood Sectors (High Impact, Low Capital)

1. **Agriculture & Food Processing**

- Repair irrigation
- Provide seeds, tools, micro-credit
- Restart local mills, dairies, and canneries

2. **Construction & Materials**
   - Support local cement, brick, steel recycling
   - Train skilled labor (masons, electricians, plumbers)
3. **Small Manufacturing & Services**
   - Textiles, furniture, repair shops
   - Digital services where possible (outsourcing, IT)

These sectors create **jobs fast** and reduce import dependence.

B. Microfinance and Small and Medium Enterprise (SME) Support

(a) Establish **locally governed microfinance institutions**

(b) Use **Islamic finance instruments** (murabaha, musharaka) where appropriate

(c) Guarantee loans with international development funds

This lowers risk without large capital inflows.

Phase III (5–10 Years): Unlocking Investment

A. Sanctions Navigation, Not Confrontation

(a) Expand **humanitarian-to-recovery exemptions**

(b) Establish monitored escrow mechanisms for foreign capital

(c) Use multilateral institutions (UN, World Bank, Arab funds) as intermediaries

Investors need **legal insulation**, not political endorsement.

B. Land, Property, and Legal Reform

One of the biggest investment blockers:

(a) Digitize land registries

(b) Create dispute-resolution courts

(c) Protect returning refugees' property rights

Without this, capital will not flow—period.

C. Public–Private Partnerships (PPPs)

Start with:

(a) Power generation

(b) Water utilities

(c) Ports and logistics

Structure deals so:

(a) Government retains ownership

(b) Private firms operate under long-term concessions

(c) Revenue-sharing is transparent

2. Governance & Trust Mechanisms (Cross-Cutting)

A. Anti-Corruption Safeguards

(a) Independent reconstruction authority

(b) Public dashboards of spending

(c) Third-party audits by neutral actors

B. Social Reconciliation Through Reconstruction

(a) Mixed-community projects

(b) Labor quotas for displaced persons

(c) Reconstruction tied to local peace agreements

Rebuilding **relationships** is as important as rebuilding roads.

3. Who Pays? A Realistic Financing Mix

Source	**Role**
International aid	Early stabilization
Syrian diaspora	Medium-term housing & SMEs
Regional funds (Arab states)	Infrastructure
IFIs (World Bank, Islamic Development Bank)	Guarantees & risk-sharing
Private sector	Later-stage utilities & logistics

No single source can do this alone.

4. What Success Looks Like (Not a "New Syria")

Success is **not** rapid modernization or full political resolution.

Success is:

(a) People working

(b) Children in school

(c) Food produced locally

(d) Power on most days

(e) Refugees choosing to return voluntarily

Reconstruction is a **decade-long process**, not a postwar moment.