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An Evaluation of Recycled Concrete Aggregates in Road Construction

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WAKA KOTAHI

GREEN VISION
RECYCLING

Key questions:

- What is the importance of RCAg?
- What is the necessity of using RCAg in NZ?
- What actions need to be taken?

Problem:

- Population growth → Increase Construction → Natural RES. Extraction
- Mining → Natural Agg. transport → GHG emission.
  - → High final price → Economic dissatisfaction
- GEN non-decaying waste materials and the lack of landfill



Solution:

Urgent need to investigate adverse effects of NAg.

”Use of recycled waste from old concrete structures as a new recycled source of construction materials”

Demolished Concrete

Recycled Concrete Aggregates (RCAg)

Importance of RC:

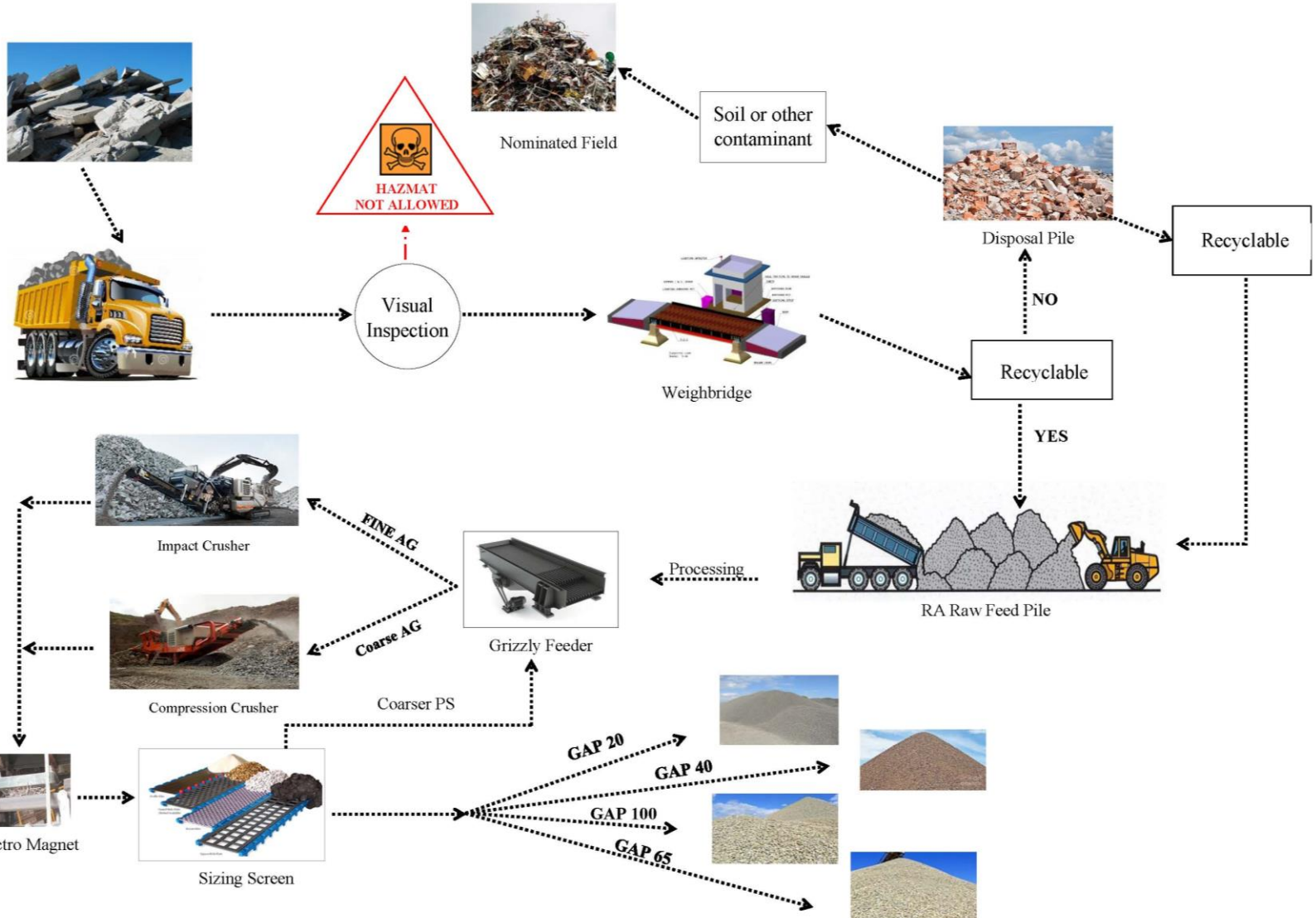
Concrete, second most consumed material
25 billion tones/year.

- Valuable resource for pavement construction

- High grade product
- Protecting natural resources

- Protecting the environment
- Potential for cost saving
- Assisting to reach sustainable development

Recycling Process



International experiences

- ***United State:***
  - ✓ Publishing a memorandum by FHWA in 2002
  - ✓ GEN 130 million tons/year of C&D waste
  - ✓ Applying 70% of RCA as a granular material in base layers

- ***Australia:***
  - ✓ Start the technology of using RCA in lightly trafficked road in 1990s
  - ✓ GEN 1.5 million tons of C&D waste : REC 70% in 2004-5 in SA
  - ✓ PROD 0.5 million tons/year RCA in SA from building demolition waste and applying in pavement construction

International experiences

- ***Europe :***
  - ✓ 1945 to 2000: 600×106 m3 waste material in rebuilding of Germany after World War II
  - ✓ 1998: 350,000 tons of crushed concrete in base layers of Finland

- ***New Zealand:***
  - ✓ Auckland city: disposes 550,000 tons/year C&D in fill sites
  - ✓ Waste concrete and glass represent 11% of the total road aggregate demand
  - ✓ Existence of high quality aggregate in Auckland region
  - ✓ RAg as an alternative in road construction has not been widely accepted.

Specifications

Country	Organisation	Specifications	Description
New Zealand	New Zealand Transport Agency	NZTA M4/M3	Specification for Base layers Aggregate
	Auckland Transport	Draft	Specification for RCAg
Australia	Roads Corporation of Victoria	VicRoads 820	Crushed Concrete for Pavement Subbase and Light Duty Base
	Department for Transport, Energy and Infrastructure,	DTEI TSA2428	Standard Specification for Supply and Delivery of Pavement Materials
	Institute of Public Works Engineering Australia	IPWEA	Specification for Supply of Recycled Material for Pavements, Earthworks & Drainage
	Roads and Traffic Authority NSW	RTA 3051	Granular Base and Subbase Materials for Surfaced Road Pavements
	Main Roads Western Australia	MRWA 501	Pavements
United States	United States Department of Transportation	DOT	Standard Specifications for Road Construction
	U.S Department of Transportation Federal Highway Administration	FHWA	Transportation Applications of Recycled Concrete Aggregate

Review of previous research

Properties	Natural Agg.	Recycled Concrete Agg.
OMC (%)	6-8%	10-15%
MDD (g/cm3)	2-2.5	1.7-2.1
CBR* (%)	>60	>60
UCS (Kpa)	200-260	300-380
RM (Mpa)	270-450	340-715
LAA (%)	20-40	30-60
Wet Strength (kN)	>100	50-70

* Max OMC

RCAg importance for NZ

- Restricted access to aggregates quarry in the Auckland region
- Developed aggregates resources on the boundaries of Auckland region
- Considerable quantity of waste aggregate material in New Zealand.
- 25% of construction and demolition waste is concrete
- Scarce of suitable landfill sites and increasing landfill levy

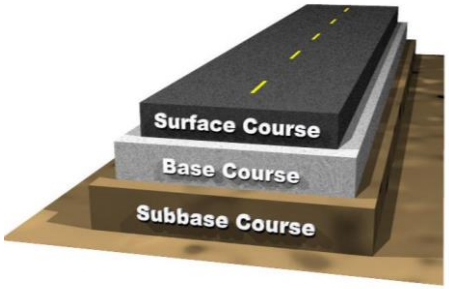
RCAg restrictions in NZ

- Shortage of New Zealand Specification documents for recycled materials
- Lack of verifiable testing research that is local to New Zealand.
- Investor's risk averseness and decrease tendency to use RCAg.

"Recycled Aggregate & Waste for Road Construction Project"

Research objectives

- Evaluate the application of RCAg as an unbound granular material in base layers



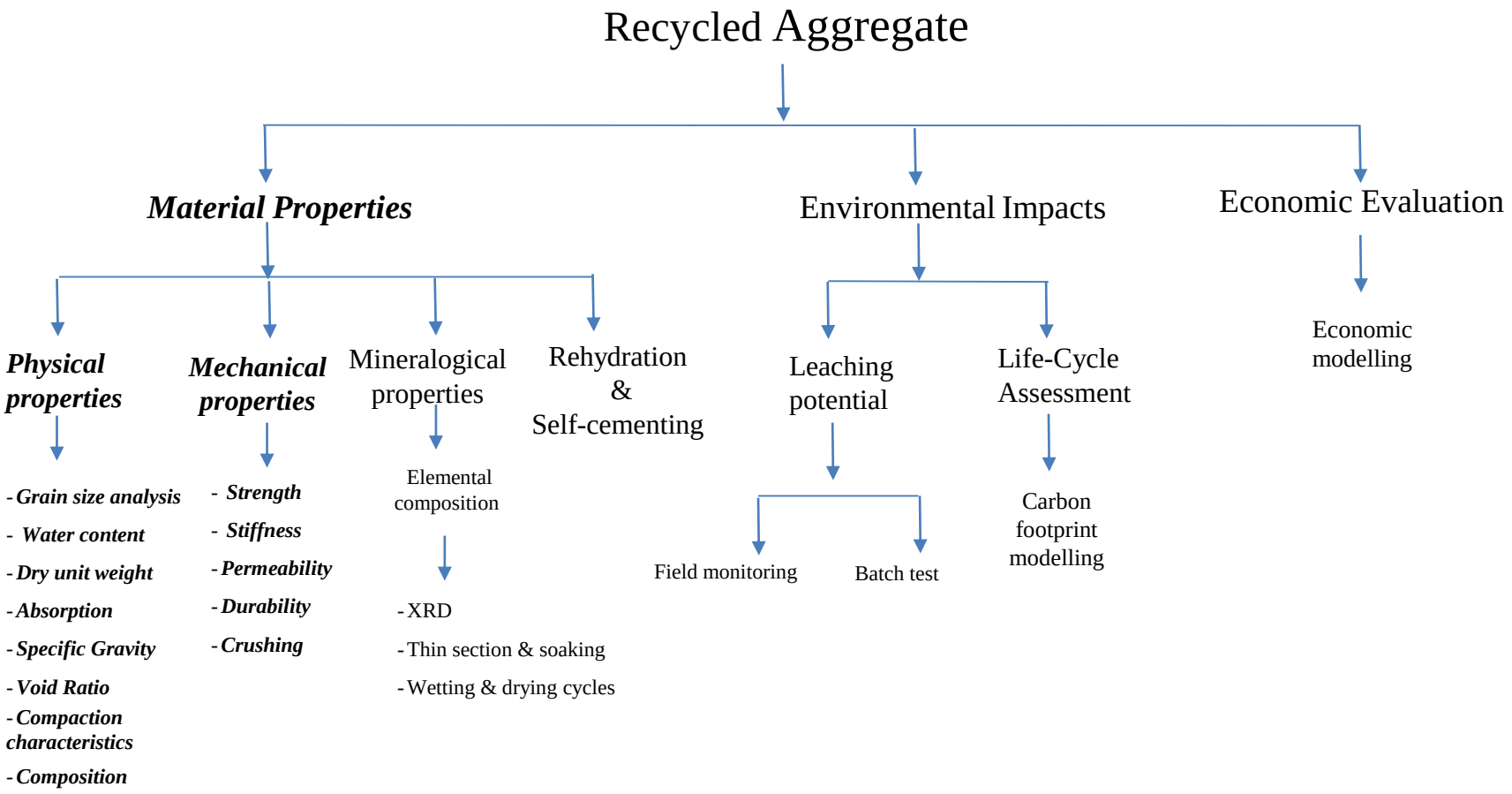
- Develop a local RAg Specification

  Auckland Transport Code of Practice (ATCOP)

  NZTA Engineering Standards

  National construction design standards

Research plan



Experimental test

Investigating physical properties & engineering performance of RCAg

Lab tests:

- Production Properties Tests
- Source Properties Tests
- Performance Properties Tests

Summary

- Environmental restrictions of exploring natural aggregate and the growing concern about the lack of waste disposal landfills have led to increased interest of governments and industries to use recycled aggregate in engineered structures

- Numerous studies have been conducted on RAg . They reflects that the use of recycled aggregates is a viable alternative to pavement construction and test results show that the RCAg can compete with typical virgin road aggregates

- Ongoing research at The University of Auckland seeks to:
  - Determine the quantity of available recycled aggregate in the Auckland region's market
  - Investigate the characteristics and performance of existing recycled concrete
  - 'Fit for purpose' criteria by evaluating where these materials may economically be used
  - Evaluating the environmental impacts and carbon footprint

Acknowledgment

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Thank you